



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/US95/02420 <b>(22) International Filing Date:</b> 24 February 1995 (24.02.95)  <b>(30) Priority Data:</b> 08/207,580 7 March 1994 (07.03.94) US  <b>(60) Parent Application or Grant</b> (63) Related by Continuation US 08/207,580 (CIP) Filed on 7 March 1994 (07.03.94)  <b>(71) Applicant (for all designated States except US):</b> VERTEX PHARMACEUTICALS INCORPORATED [US/US]; 40 Allston Street, Cambridge, MA 02139-4211 (US).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> TUNG, Roger, Dennis [US/US]; 54 Richfield Road, Arlington, MA 02174 (US). SALITURO, Francesco, Gerald [US/US]; 25 Baker Drive, Marlborough, MA 01752 (US). DEININGER, David, D. [US/US]; 4 Frazer Road, Arlington, MA 02174 (US). MUR- CKO, Mark, Andrew [US/US]; 520 Marshall Street, Hollis-		<p>ton, MA 01746 (US). NOVAK, Perry, Michael [US/US]; 35 Debbie Lane, Milford, MA 01757 (US). BHISETTI, Govinda, Rao [US/US]; 70 Grassland Street, Lexington, MA 02173 (US).</p> <p><b>(74) Agents:</b> HALEY, James, F., Jr. et al.; Fish &amp; Neave, 1251 Avenue of the Americas, New York, NY 10020-1104 (US).</p> <p><b>(81) Designated States:</b> AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TT, UA, UG, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).</p> <p><b>Published</b> With international search report.</p>
<b>(54) Title:</b> SULPHONAMIDE DERIVATIVES AS ASPARTYL PROTEASE INHIBITORS  <b>(57) Abstract</b>  This invention relates to a novel class of sulfonamides that are aspartyl protease inhibitors. In one embodiment, this invention relates to a novel class of aspartyl protease inhibitors characterized by specific structural and physicochemical features. This invention also relates to pharmaceutical compositions comprising these compounds. The compounds and pharmaceutical compositions of this invention are particularly well suited for inhibiting HIV-1 and HIV-2 protease activity and consequently, may be advantageously used as anti-viral agents against the HIV-1 and HIV-2 viruses. This invention also relates to methods for inhibiting aspartyl protease activity and methods for treating viral infections using the compounds and compositions of this invention.		

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## SULPHONAMIDE DERIVATIVES AS ASPARTYL PROTEASE INHIBITORS

TECHNICAL FIELD OF THE INVENTION

5 The present invention relates to a novel class of sulfonamides which are aspartyl protease inhibitors. In one embodiment, this invention relates to a novel class of HIV aspartyl protease inhibitors characterized by specific structural and physicochemical features. This invention also relates to pharmaceutical compositions comprising these  
10 compounds. The compounds and pharmaceutical compositions of this invention are particularly well suited for inhibiting HIV-1 and HIV-2 protease activity and consequently, may be advantageously used as anti-viral agents against the HIV-1 and HIV-2 viruses. This  
15 invention also relates to methods for inhibiting aspartyl protease activity and methods for treating viral infections using the compounds and compositions of this invention.

BACKGROUND OF THE INVENTION

20 The human immunodeficiency virus ("HIV") is the causative agent for acquired immunodeficiency syndrome ("AIDS") -- a disease characterized by the destruction of the immune system, particularly of CD4<sup>+</sup> T-cells, with attendant susceptibility to opportunistic  
25 infections -- and its precursor AIDS-related complex

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("ARC") -- a syndrome characterized by symptoms such as persistent generalized lymphadenopathy, fever and weight loss.

As in the case of several other retroviruses, HIV encodes the production of a protease which carries out post-translational cleavage of precursor polypeptides in a process necessary for the formation of infectious virions (S. Crawford et al., "A Deletion Mutation in the 5' Part of the pol Gene of Moloney Murine Leukemia Virus Blocks Proteolytic Processing of the gag and pol Polyproteins", J. Virol., 53, p. 899 (1985)). These gene products include pol, which encodes the virion RNA-dependent DNA polymerase (reverse transcriptase), an endonuclease, HIV protease, and gag, which encodes the core-proteins of the virion (H. Toh et al., "Close Structural Resemblance Between Putative Polymerase of a Drosophila Transposable Genetic Element 17.6 and pol gene product of Moloney Murine Leukemia Virus", EMBO J., 4, p. 1267 (1985); L.H. Pearl et al., "A Structural Model for the Retroviral Proteases", Nature, pp. 329-351 (1987); M.D. Power et al., "Nucleotide Sequence of SRV-1, a Type D Simian Acquired Immune Deficiency Syndrome Retrovirus", Science, 231, p. 1567 (1986)).

A number of synthetic anti-viral agents have been designed to target various stages in the replication cycle of HIV. These agents include compounds which block viral binding to CD4<sup>+</sup> T-lymphocytes (for example, soluble CD4), and compounds which interfere with viral replication by inhibiting viral reverse transcriptase (for example, didanosine and zidovudine (AZT)) and inhibit integration of viral DNA into cellular DNA (M.S. Hirsh and R.T. D'Aquila, "Therapy for Human Immunodeficiency Virus Infection", N.Eng.J.Med., 328, p. 1686 (1993)). However, such

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agents, which are directed primarily to early stages of viral replication, do not prevent the production of infectious virions in chronically infected cells. Furthermore, administration of some of these agents in effective amounts has led to cell-toxicity and unwanted side effects, such as anemia and bone marrow suppression.

More recently, drug design efforts have been directed toward creating compounds which inhibit the formation of infectious virions by interfering with the processing of viral polyprotein precursors. Processing of these precursor proteins requires the action of virus-encoded proteases which are essential for replication (Kohl, N.E. et al. "Active HIV Protease is Required for Viral Infectivity" Proc. Natl. Acad. Sci. USA, 85, p. 4686 (1988)). The anti-viral potential of HIV protease inhibition has been demonstrated using peptidal inhibitors. Such peptidal compounds, however, are typically large and complex molecules that tend to exhibit poor bioavailability and are not generally consistent with oral administration. Accordingly, the need still exists for compounds that can effectively inhibit the action of viral proteases, for use as agents for preventing and treating chronic and acute viral infections. Such agents would be expected to act as effective therapeutic agents in their own right. In addition, since they act at a separate stage in the virus life cycle from previously described antiretroviral agents, the administration of a combination of agents would be expected to result in increased therapeutic efficacy.

#### SUMMARY OF THE INVENTION

The present invention provides a novel class of compounds, and pharmaceutically acceptable

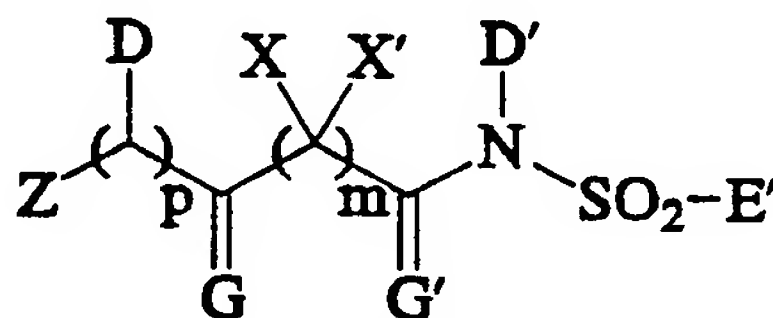
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derivatives thereof, that are useful as inhibitors of aspartyl proteases, and in particular, HIV aspartyl protease. These compounds can be used alone or in combination with other therapeutic or prophylactic agents, such as anti-virals, antibiotics, immunomodulators or vaccines, for the treatment or prophylaxis of viral infection.

According to a preferred embodiment, the compounds of this invention are capable of inhibiting HIV viral replication in human CD<sub>4</sub><sup>+</sup> cells including T-cells, monocytic lines including macrophages and dendrocytes and other permissive cells. These compounds are useful as therapeutic and prophylactic agents to treat or prevent infection by HIV-1 and related viruses which may result in asymptomatic infection, AIDS-related complex ("ARC"), acquired immunodeficiency syndrome ("AIDS"), or similar disease of the immune system.

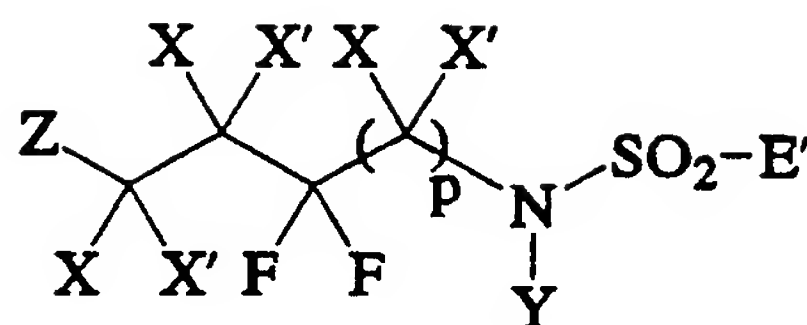
It is a principal object of this invention to provide a novel class of sulfonamides that are aspartyl protease inhibitors, and particularly, HIV aspartyl protease inhibitors. This novel class of sulfonamides is represented by formulas I and II:

Formula I:



( I )

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Formula II:

( II )

wherein:

each Z is selected from the group consisting of -N(D)SO<sub>2</sub>E; -N(H)A; -N(D)A; -N(H)E; -N(H)C(O)N(D)(E);  
 5 -N(H)-Het; -Het and -N(D)-Het;

each A is independently selected from the group consisting of H; Het; -R<sup>1</sup>-Het; -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy,  
 10 C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>), -NR<sup>2</sup>-CO-OR<sup>2</sup> and -CO-N(R<sup>2</sup>)(R<sup>2</sup>); and -R<sup>1</sup>-C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het,  
 -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>) and -CO-N(R<sup>2</sup>)(R<sup>2</sup>);

15 each Het is independently selected from the group consisting of C<sub>3</sub>-C<sub>7</sub> cycloalkyl; C<sub>5</sub>-C<sub>7</sub> cycloalkenyl; C<sub>6</sub>-C<sub>10</sub> aryl; phenyl fused with heterocycle; and heterocycle; wherein any member of said Het may be optionally substituted with one or more substituents  
 20 selected from the group consisting of oxo, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NHOH, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), -S(O)<sub>2</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -C(O)-R<sup>2</sup>, -S(O)<sub>n</sub>-R<sup>2</sup>, -OCF<sub>3</sub>, -S(O)<sub>n</sub>-D, -N(R<sup>2</sup>)-S(O)<sub>2</sub>(R<sup>2</sup>), halo, -CF<sub>3</sub>, -NO<sub>2</sub>, -R<sup>6</sup>, -O-R<sup>6</sup>, -C(O)N(D)(D) and -C(O)N(H)D;

25 each D and D' is independently selected from the group consisting of R<sup>6</sup>; -N(R<sup>2</sup>)(R<sup>2</sup>); C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-R<sup>6</sup>, -S-R<sup>6</sup> and R<sup>6</sup>; C<sub>2</sub>-C<sub>4</sub> alkenyl, which may be optionally

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substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-R<sup>6</sup> and R<sup>6</sup>; C<sub>3</sub>-C<sub>6</sub> cycloalkyl, which may be optionally substituted with or fused with R<sup>6</sup>; and C<sub>5</sub>-C<sub>6</sub> cycloalkenyl, which may be optionally substituted with or fused with R<sup>6</sup>;

each E and E' is independently selected from the group consisting of Het; -O-Het; Het-Het; -O-R<sup>3</sup>; -NR<sup>2</sup>R<sup>3</sup>; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; and C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het;

each R<sup>1</sup> is independently selected from the group consisting of -C(O)-, -S(O)<sub>2</sub>-, -C(O)-C(O)-, -O-C(O)-, -O-S(O)<sub>2</sub>-, -NR<sup>2</sup>-S(O)<sub>2</sub>-, -NR<sup>2</sup>-C(O)- and -NR<sup>2</sup>-C(O)-C(O)-;

each R<sup>2</sup> is independently selected from the group consisting of H, -R<sup>6</sup>, and C<sub>1</sub>-C<sub>4</sub> alkyl optionally substituted with R<sup>6</sup>;

each R<sup>3</sup> is independently selected from the group consisting of H, Het, C<sub>1</sub>-C<sub>6</sub> alkyl and C<sub>2</sub>-C<sub>6</sub> alkenyl wherein any member of said R<sup>3</sup>, except H, may be optionally substituted with one or more substituents selected from the group consisting of -OR<sup>2</sup>, -C(O)-NH-R<sup>2</sup>, -S(O)<sub>n</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), Het, -CN, -SR<sup>2</sup>, -CO<sub>2</sub>R<sup>2</sup>, NR<sup>2</sup>-C(O)-R<sup>2</sup>;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -C(O)-NHR<sup>2</sup>, -S(O)<sub>2</sub>-NHR<sup>2</sup>, halo, -NR<sup>2</sup>-C(O)-R<sup>2</sup>, -CN, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(D)(D) and -C(O)N(H)D;

each R<sup>5</sup> is independently selected from the group consisting of H and C<sub>1</sub>-C<sub>3</sub> alkyl;

each R<sup>6</sup> is independently selected from the group consisting of aryl, carbocycle and heterocycle, wherein said carbocycle or heterocycle may be optionally substituted with one or more groups selected

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from the group consisting of oxo,  $-OR^5$ ,  $-R^5$ ,  $-N(R^5)(R^5)$ ,  $-N(R^5)-C(O)-R^5$ ,  $-R^5-OH$ ,  $-CN$ ,  $-CO_2R^5$ ,  $-C(O)-N(R^5)(R^5)$ , halo and  $-CF_3$ ;

each  $n$  is independently 1 or 2;

5  $m$  is an integer selected from 1, 2 and 3;

$p$  is an integer selected from 0 and 1;

each  $G$  and  $G'$  is independently selected from the group consisting of  $H_2$  and  $O$ ;

10 each  $X$  and  $X'$  is independently selected from the group consisting of hydrogen;  $-OH$ ;  $-NH_2$ ;  $-SH$ ;  $D$ ; halogen and, if  $X$  and  $X'$  are taken together, oxygen; and

each  $Y$  is independently selected from the group consisting of hydrogen and  $D$ .

15 It is also an object of this invention to provide pharmaceutical compositions comprising the sulfonamides of formulas I and II, methods for preparing those sulfonamides, and methods for their use as inhibitors of aspartyl protease, and particularly,  
20 HIV aspartyl protease.

It is a further object of this invention to provide methods for treating viral diseases, and in particular HIV-related diseases, using the compounds and compositions of this invention.

## 25 DETAILED DESCRIPTION OF THE INVENTION

In order that the invention herein described may be more fully understood, the following detailed description is set forth. In the description, the following abbreviations are used:

30	<u>Designation</u>	<u>Reagent or Fragment</u>
	Ac	acetyl
	Me	methyl
	Et	ethyl
	Bn	benzyl

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	Trityl	triphenylmethyl
	Asn	D- or L-asparagine
	Ile	D- or L-isoleucine
	Phe	D- or L-phenylalanine
5	Val	D- or L-valine
	Boc	tert-butoxycarbonyl
	Cbz	benzyloxycarbonyl (carbobenzyloxy)
	Fmoc	9-fluorenylmethoxycarbonyl
	DCC	dicyclohexylcarbodiimide
10	DIC	diisopropylcarbodiimide
	EDC	1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride
	HOBt	1-hydroxybenzotriazole
	HOSu	1-hydroxysuccinimide
15	TFA	trifluoroacetic acid
	DIEA	diisopropylethylamine
	DBU	1,8-diazabicyclo(5.4.0)undec-7-ene
	EtOAc	ethyl acetate
	t-Bu	tert-butyl
20	iBu	iso-butyl
	DMF	dimethylformamide
	THP	tertrahydropyran
	THF	tetrahydrofuran
	DMSO	dimethylsulfoxide

25           The following terms are employed herein:

Unless expressly stated to the contrary, the terms "-SO<sub>2</sub>-" and "-S(O)<sub>2</sub>-" as used herein refer to a sulfone or sulfone derivative (i.e., both appended groups linked to the S), and not a sulfinate ester.

30           The term "alkoxy" refers to an alkyl ether radical, wherein the term "alkyl" is as defined above. Examples of suitable alkyl ether radicals include, but are not limited to, methoxy, ethoxy, n-propoxy, isopropoxy, n-butoxy, isobutoxy, sec-butoxy, tert-butoxy and the like.

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The term "alkyl", alone or in combination with any other term, refers to a straight-chain or branch-chain saturated aliphatic hydrocarbon radical containing the specified number of carbon atoms, or where no number is specified, preferably from 1-10 and more preferably from 1-5 carbon atoms. Examples of alkyl radicals include, but are not limited to, methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, tert-butyl, pentyl, isoamyl, n-hexyl and the like.

The term "alkenyl", alone or in combination with any other term, refers to a straight-chain or branched-chain mono- or poly-unsaturated aliphatic hydrocarbon radical containing the specified number of carbon atoms, or where no number is specified, preferably from 2-10 carbon atoms and more preferably, from 2-6 carbon atoms. Examples of alkenyl radicals include, but are not limited to, ethenyl, E- and Z-propenyl, isopropenyl, E- and Z-butenyl, E- and Z-isobutenyl, E- and Z-pentenyl, E- and Z-hexenyl, E,E-, E,Z-, Z,E- and Z,Z-hexadienyl and the like.

The term "anti-viral agent" or "anti-retroviral agent" refers to a compound or drug which possesses viral inhibitory activity. Such agents include reverse transcriptase inhibitors (including nucleoside and non-nucleoside analogs) and protease inhibitors. Preferably the protease inhibitor is an HIV protease inhibitor. Examples of nucleoside analog reverse transcriptase inhibitors include, but are not limited to, zidovudine (AZT), dideoxycytidine (ddC), didanosine (ddI), stavudine (d4T), 3TC, 935U83, 1592U89 and 524W91. Examples of non-nucleoside analog reverse transcriptase inhibitors include, but are not limited to TIBO, delavirdine (U90) and nevirapine. Examples of HIV protease inhibitors include, but are not limited

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to, saquinavir (Ro 31-8959), L-735,524, ABT 538 (A80538), AG 1341, XM 412, XM 450, BMS 186318 and CPG 53,437.

5           The term "aryl", alone or in combination with any other term, refers to a carbocyclic aromatic radical (such as phenyl or naphthyl) containing the specified number of carbon atoms, preferably from 6-14 carbon atoms, and more preferably from 6-10 carbon atoms. Examples of aryl radicals include, but are not  
10       limited to phenyl, naphthyl, indenyl, indanyl, azulenyl, fluorenyl, anthracenyl and the like.

          The term "backbone" refers to the structural representation of a compound of this invention, as set forth in the figures drawn in this application.

15           The term "carbocycle" refers to a non-aromatic stable 3- to 8-membered carbon ring which may be saturated, mono-unsaturated or poly-unsaturated. The carbocycle may be attached at any endocyclic carbon atom which results in a stable structure. Preferred  
20       carbocycles have 5-6 carbons.

          The term "heterocycle", unless otherwise defined herein, refers to a stable 3-7 membered monocyclic heterocyclic ring or 8-11 membered bicyclic heterocyclic ring which is either saturated or  
25       unsaturated, and which may be optionally benzofused if monocyclic. Each heterocycle consists of one or more carbon atoms and from one to four heteroatoms selected from the group consisting of nitrogen, oxygen and sulfur. As used herein, the terms "nitrogen and sulfur  
30       heteroatoms" include any oxidized form of nitrogen and sulfur, and the quaternized form of any basic nitrogen. In addition, any ring nitrogen or carbon may be optionally substituted with a substituent R<sup>2</sup>, as defined herein for compounds of formula I or II. A heterocycle  
35       may be attached at any endocyclic carbon or heteroatom

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which results in the creation of a stable structure. Preferred heterocycles include 5-7 membered monocyclic heterocycles and 8-10 membered bicyclic heterocycles. Preferred heterocycles defined above include, for  
5 example, benzimidazolyl, imidazolyl, imidazolinoyl, imidazolidinyl, quinolyl, isoquinolyl, indolyl, indazolyl, indazolinolyl, perhydropyridazyl, pyridazyl, pyridyl, pyrrolyl, pyrrolinyl, pyrrolidinyl, pyrazolyl, pyrazinyl, quinoxolyl, piperidinyl, pyranyl,  
10 pyrazolinyl, piperazinyl, pyrimidinyl, pyridazinyl, morpholinyl, thiamorpholinyl, furyl, thienyl, triazolyl, thiazolyl,  $\beta$ -carbolinyl, tetrazolyl, thiazolidinyl, benzofuranoyl, thiamorpholinyl sulfone, oxazolyl, benzoxazolyl, oxopiperidinyl, oxopyrrolidinyl,  
15 oxoazepinyl, azepinyl, isoxazolyl, isothiazolyl, furazanyl, tetrahydropyranyl, tetrahydrofuranyl, thiazolyl, thiadiazoyl, dioxolyl, dioxinyl, oxathieryl, benzodioxolyl, dithieryl, thiophenyl, tetrahydrothiophenyl, sulfolanyl, dioxanyl, dioxolanyl,  
20 tetrahydrofurodihydrofuranyl, tetrahydropyranodihydrofuranyl, dihydropyranyl, tetrahydrofurofuranyl and tetrahydropyranofuranyl.

The term "halo" refers to a radical of fluorine, chlorine, bromine or iodine.

25 The terms "HIV protease" and "HIV aspartyl protease" are used interchangeably and refer to the aspartyl protease encoded by the human immunodeficiency virus type 1 or 2. In a preferred embodiment of this invention, these terms refer to the human  
30 immunodeficiency virus type 1 aspartyl protease.

The term "substituted", whether preceded by the term "optionally" or not, and substitutions contained in formulas of this invention, refer to the replacement of one or more hydrogen radicals in a given  
35 structure with the radical of a specified substituent.

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When more than one position in a given structure may be substituted with more than one substituent selected from a specified group, the substituents may be either the same or different at every position (for example, the moiety  $-N(R^2)(R^2)$  or  $-\text{phenyl}-R^7$ ). Typically, when a structure may be optionally substituted, 0-3 substitutions are preferred, and 0-1 substitutions is more preferred. Most preferred substituents are those which enhance protease inhibitory activity or intracellular antiviral activity in permissive mammalian cells or immortalized mammalian cell lines, or which enhance deliverability by enhancing solubility characteristics or enhancing pharmacokinetic or pharmacodynamic profiles as compared to the unsubstituted compound. Other more preferred substituents include those used in the compounds shown in Tables 1-8 and the most preferred substituents include those used in the compounds in Tables 1, 5, 6, and 7.

The term " $R^2$ " when used as a linker between two radicals excludes  $R^2$  as H.

The term " $-\text{phenyl}-R^7$ " as used herein refers to a phenyl radical having  $R^7$ , the same or different, at each free position and expressly envisions polycyclic ring systems formed by joining multiple  $R^7$  substituents on the phenyl ring. Preferably, 0-3  $R^7$  in a particular phenyl radical are not H. In addition to H,  $-\text{OH}$ ,  $-\text{OCH}_3$ ,  $-\text{NH}_2$ ,  $-\text{NO}_2$  and CN are preferred  $R^7$ . Such ring systems are preferably mono- or bi-cyclic. These ring systems may be carbocyclic or may optionally contain one or more heteroatoms, such as N, O or S. Preferred ring systems include benzimidazolyl, benzoxazolyl, benzothiazolyl, benztriazolyl,

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imidazolyl, indolyl, isoxazolyl, isothiazolyl,  
oxazolyl, thianaphthenyl, thiazolyl, and triazolyl.

The term "pharmaceutically effective amount" refers to an amount effective in treating HIV infection in a patient either as monotherapy or in combination with other agents. The term "treating" as used herein refers to the alleviation of symptoms of a particular disorder in a patient or the improvement of an ascertainable measurement associated with a particular disorder. Specifically, with respect to HIV, effective treatment using the compounds and compositions of this invention would result in an improvement in an HIV associated ascertainable measurement. The term "prophylactically effective amount" refers to an amount effective in preventing HIV infection in a patient. As used herein, the term "patient" refers to a mammal, including a human.

The term "pharmaceutically acceptable carrier or adjuvant" refers to a carrier or adjuvant that may be administered to a patient, together with a compound of this invention, and which does not destroy the pharmacological activity thereof and is nontoxic when administered in doses sufficient to deliver a therapeutic amount of the antiretroviral agent.

As used herein, the compounds of this invention, including the compounds of formula I and II are defined to include pharmaceutically acceptable derivatives or prodrugs thereof. A "pharmaceutically acceptable derivative or prodrug" means any pharmaceutically acceptable salt, ester, salt of an ester, or other derivative of a compound of this invention which, upon administration to a recipient, is capable of providing (directly or indirectly) a compound of this invention or an inhibitorily active metabolite or residue thereof. Particularly favored

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derivatives and prodrugs are those that increase the bioavailability of the compounds of this invention when such compounds are administered to a mammal (e.g., by allowing an orally administered compound to be more readily absorbed into the blood) or which enhance delivery of the parent compound to a biological compartment (e.g., the brain or lymphatic system) relative to the parent species.

Pharmaceutically acceptable salts of the compounds of this invention include those derived from pharmaceutically acceptable inorganic and organic acids and bases. Examples of suitable acids include hydrochloric, hydrobromic, sulfuric, nitric, perchloric, fumaric, maleic, phosphoric, glycollic, lactic, salicylic, succinic, toluene-p-sulfonic, tartaric, acetic, citric, methanesulfonic, ethanesulfonic, formic, benzoic, malonic, naphthalene-2-sulfonic and benzenesulfonic acids. Other acids, such as oxalic, while not in themselves pharmaceutically acceptable, may be employed in the preparation of salts useful as intermediates in obtaining the compounds of the invention and their pharmaceutically acceptable acid addition salts.

Salts derived from appropriate bases include alkali metal (e.g., sodium), alkaline earth metal (e.g., magnesium), ammonium and  $N-(C_{1-4} \text{ alkyl})_4^+$  salts.

The term "thiocarbamates" refers to compounds containing the functional group  $N-SO_2-O$ .

The term "if X and X' are taken together, oxygen" refers to a carbonyl formed on the carbon that bears that X and X'. When X and X' are both geminal substituents on the same carbon, if one is -OH the other is H.

The compounds of this invention contain one or more asymmetric carbon atoms and thus occur as

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racemates and racemic mixtures, single enantiomers, diastereomeric mixtures and individual diastereomers. All such isomeric forms of these compounds are expressly included in the present invention. Each stereogenic carbon may be of the R or S configuration. Although the specific compounds exemplified in this application may be depicted in a particular stereochemical configuration, compounds having either the opposite stereochemistry at any given chiral center or mixtures thereof are also envisioned.

Combinations of substituents and variables envisioned by this invention are only those that result in the formation of stable compounds. The term "stable", as used herein, refers to compounds which possess stability sufficient to allow manufacture and which maintains the integrity of the compound for a sufficient period of time to be useful for the purposes detailed herein (e.g., therapeutic or prophylactic administration to a mammal or for use in affinity chromatography applications). Typically, such compounds are stable at a temperature of 40°C or less, in the absence of moisture or other chemically reactive conditions, for at least a week.

The compounds of the present invention may be used in the form of salts derived from inorganic or organic acids. Included among such acid salts, for example, are the following: acetate, adipate, alginate, aspartate, benzoate, benzenesulfonate, bisulfate, butyrate, citrate, camphorate, camphorsulfonate, cyclopentanepropionate, digluconate, dodecylsulfate, ethanesulfonate, fumarate, glucoheptanoate, glycerophosphate, hemisulfate, heptanoate, hexanoate, hydrochloride, hydrobromide, hydroiodide, 2-hydroxyethanesulfonate, lactate, maleate, methanesulfonate, 2-naphthalenesulfonate, nicotinate,

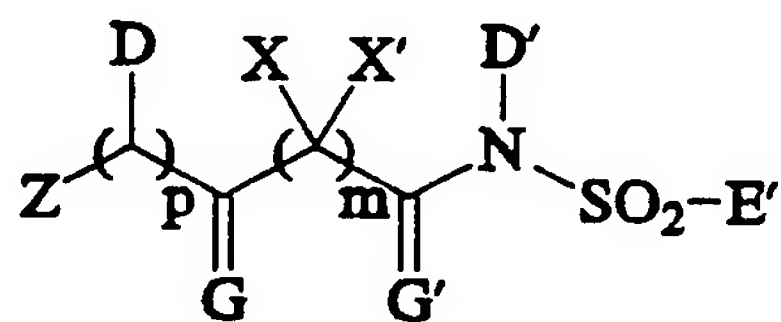
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oxalate, pamoate, pectinate, persulfate, 3-phenylpropionate, picrate, pivalate, propionate, succinate, tartrate, thiocyanate, tosylate and undecanoate.

5                   This invention also envisions the quaternization of any basic nitrogen-containing groups of the compounds disclosed herein. The basic nitrogen can be quaternized with any agents known to those of ordinary skill in the art including, for example, lower  
10 alkyl halides, such as methyl, ethyl, propyl and butyl chloride, bromides and iodides; dialkyl sulfates including dimethyl, diethyl, dibutyl and diamyl sulfates; long chain halides such as decyl, lauryl, myristyl and stearyl chlorides, bromides and iodides;  
15 and aralkyl halides including benzyl and phenethyl bromides. Water or oil-soluble or dispersible products may be obtained by such quaternization.

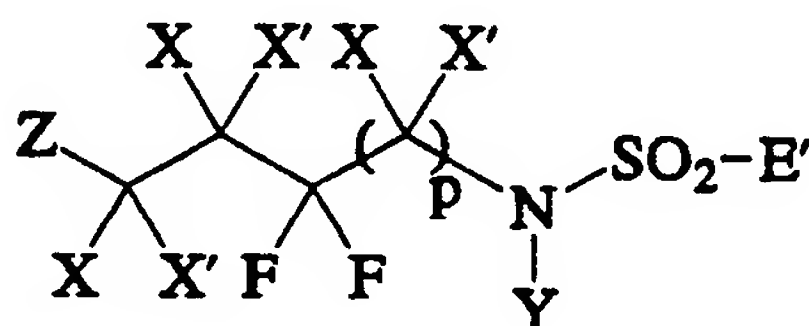
The sulfonamides of this invention are those of formulas I and II:

20   Formula I:



( I )

Formula II:



( II )

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wherein:

each Z is selected from the group consisting of -N(D)SO<sub>2</sub>E; -N(H)A; -N(D)A; -N(H)E; -N(H)C(O)N(D)(E); -N(H)-Het; -Het and -N(D)-Het;

5 each A is independently selected from the group consisting of H; Het; -R<sup>1</sup>-Het; -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>), -NR<sup>2</sup>-CO-OR<sup>2</sup> and -CO-N(R<sup>2</sup>)(R<sup>2</sup>); and -R<sup>1</sup>-C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be  
10 optionally substituted with one or more groups selected from the group consisting of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>) and -CO-N(R<sup>2</sup>)(R<sup>2</sup>);

each Het is independently selected from the  
15 group consisting of C<sub>3</sub>-C<sub>7</sub> cycloalkyl; C<sub>5</sub>-C<sub>7</sub> cycloalkenyl; C<sub>6</sub>-C<sub>10</sub> aryl; phenyl fused with heterocycle; and heterocycle; wherein any member of said Het may be optionally substituted with one or more substituents selected from the group consisting of oxo, -OR<sup>2</sup>, -R<sup>2</sup>, -  
20 N(R<sup>2</sup>)(R<sup>2</sup>), -NHOH, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), -S(O)<sub>2</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -C(O)-R<sup>2</sup>, -S(O)<sub>n</sub>-R<sup>2</sup>, -OCF<sub>3</sub>, -S(O)<sub>n</sub>-D, -N(R<sup>2</sup>)-S(O)<sub>2</sub>(R<sup>2</sup>), halo, -CF<sub>3</sub>, -NO<sub>2</sub>, -R<sup>6</sup>, -O-R<sup>6</sup>, -C(O)N(D)(D) and -C(O)N(H)D;

each D and D' is independently selected from  
25 the group consisting of R<sup>6</sup>; -N(R<sup>2</sup>)(R<sup>2</sup>); C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-R<sup>6</sup>, -S-R<sup>6</sup> and R<sup>6</sup>; C<sub>2</sub>-C<sub>4</sub> alkenyl, which may be optionally substituted with one or more groups selected from the  
30 group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-R<sup>6</sup> and R<sup>6</sup>; C<sub>3</sub>-C<sub>6</sub> cycloalkyl, which may be optionally substituted with or fused with R<sup>6</sup>; and C<sub>5</sub>-C<sub>6</sub> cycloalkenyl, which may be optionally substituted with or fused with R<sup>6</sup>;

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each E and E' is independently selected from the group consisting of Het; -O-Het; Het-Het; -O-R<sup>3</sup>; -NR<sup>2</sup>R<sup>3</sup>; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group  
 5 consisting of R<sup>4</sup> and Het; and C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het;

each R<sup>1</sup> is independently selected from the group consisting of -C(O)-, -S(O)<sub>2</sub>-, -C(O)-C(O)-, -O-C(O)-, -O-S(O)<sub>2</sub>-, -NR<sup>2</sup>-S(O)<sub>2</sub>-, -NR<sup>2</sup>-C(O)- and -NR<sup>2</sup>-C(O)-C(O)-;

each R<sup>2</sup> is independently selected from the group consisting of H, R<sup>6</sup>, and C<sub>1</sub>-C<sub>4</sub> alkyl optionally substituted with R<sup>6</sup>;

15 each R<sup>3</sup> is independently selected from the group consisting of H, Het, C<sub>1</sub>-C<sub>6</sub> alkyl and C<sub>2</sub>-C<sub>6</sub> alkenyl wherein any member of said R<sup>3</sup>, except H, may be optionally substituted with one or more substituents selected from the group consisting of -OR<sup>2</sup>, -C(O)-NH-R<sup>2</sup>,  
 20 -S(O)<sub>n</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), Het, -CN, -SR<sup>2</sup>, -CO<sub>2</sub>R<sup>2</sup>, NR<sup>2</sup>-C(O)-R<sup>2</sup>;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -C(O)-NHR<sup>2</sup>, -S(O)<sub>2</sub>-NHR<sup>2</sup>, halo, -NR<sup>2</sup>-C(O)-R<sup>2</sup>, -CN, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(D)(D) and -C(O)N(H)D;

25 each R<sup>5</sup> is independently selected from the group consisting of H and C<sub>1</sub>-C<sub>3</sub> alkyl;

each R<sup>6</sup> is independently selected from the group consisting of aryl, carbocycle and heterocycle, wherein said carbocycle or heterocycle may be  
 30 optionally substituted with one or more groups selected from the group consisting of oxo, -OR<sup>5</sup>, -R<sup>5</sup>, -N(R<sup>5</sup>)(R<sup>5</sup>), -N(R<sup>5</sup>)-C(O)-R<sup>5</sup>, -R<sup>5</sup>-OH, -CN, -CO<sub>2</sub>R<sup>5</sup>, -C(O)-N(R<sup>5</sup>)(R<sup>5</sup>), halo and -CF<sub>3</sub>;

each n is independently 1 or 2;  
 35 m is an integer selected from 1, 2 and 3;

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p is an integer selected from 0 and 1;  
each G and G' is independently selected from  
the group consisting of H<sub>2</sub> and O;  
each X and X' is independently selected from  
5 the group consisting of hydrogen; -OH; -NH<sub>2</sub>; -SH; D;  
halogen and, if X and X' are taken together, oxygen;  
each Y is independently selected from the  
group consisting of hydrogen and D.

10 Except where expressly noted to the contrary,  
the term "[variable] as defined for formula I or II",  
or any equivalent term used herein, refers to the  
definitions shown directly above. In addition, where  
no reference is made to a particular definition for a  
given variable, the definition is to be taken as that  
15 defined for formulas I and II shown directly above.

Preferred compounds of formula I include  
those compounds wherein G or G' or both are oxygen.  
More preferably, when G or G' or both are oxygen (i.e.,  
form a carbonyl with the carbon to which they are  
20 attached), the X and X' on the carbon adjacent to the  
carbonyl are independently selected from the group  
consisting of H, OH, F, or taken together, oxygen.  
Preferably, the compounds of formula I contain from 1  
to 4 carbonyls, and more preferably 1 to 3 carbonyls,  
25 in the backbone of the structures.

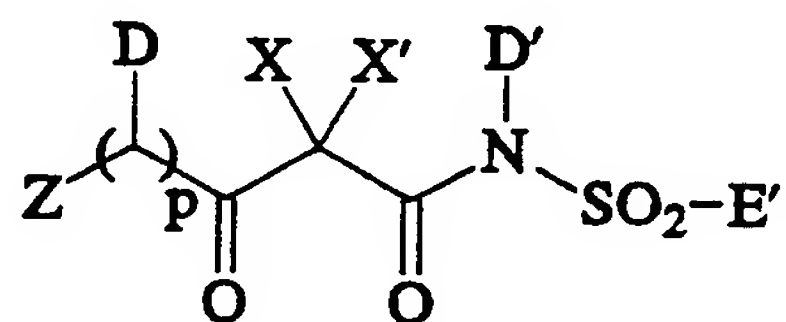
Other preferred compounds of formula I and II  
are those wherein E' is selected from -Het and -R<sup>2</sup>-Het.  
More preferred E' are those selected from the group  
consisting of -phenyl-R<sup>7</sup>; carbocycle; heterocycle  
30 optionally substituted with -NHAc, alkyl, alkoxy, -OH,  
and CF<sub>3</sub>; and C<sub>1</sub>-C<sub>6</sub> alkyl optionally substituted with Het  
wherein Het may be optionally substituted with -NH-  
C(O)-C<sub>1</sub>-C<sub>3</sub> alkyl, oxo, C<sub>1</sub>-C<sub>6</sub> alkyl, alkoxy, -OH, and CF<sub>3</sub>  
and wherein R<sup>7</sup> is selected from the group consisting of  
35 H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN,

- 20 -

-CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, halo and -CF<sub>3</sub>. Most preferred E' are those selected from the group -phenyl-R<sup>7</sup>. Preferred R<sup>7</sup> are selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, and -NO<sub>2</sub>. Most preferred R<sup>7</sup> are -NH<sub>2</sub>, -OH and -OCH<sub>3</sub>. Unless expressly noted to the contrary, the term "R<sup>7</sup>" refers to the definitions shown above.

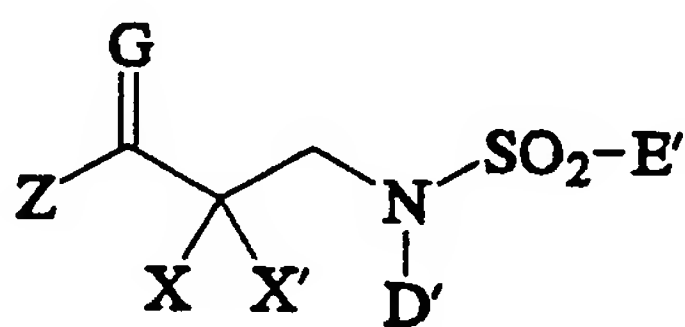
Other preferred compounds of formula I include those compounds having the structures of formulas IV, VI, VII, C and CI:

Formula IV:



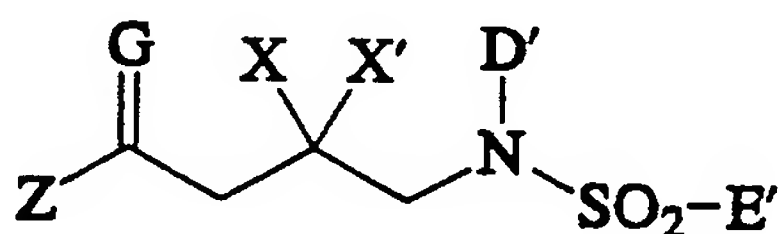
( IV )

Formula VI:



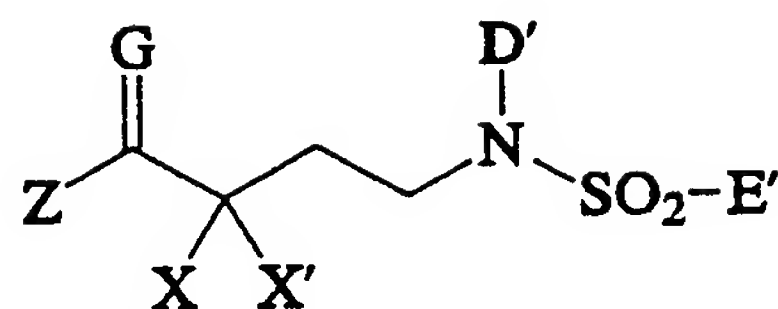
( VI )

Formula VII:

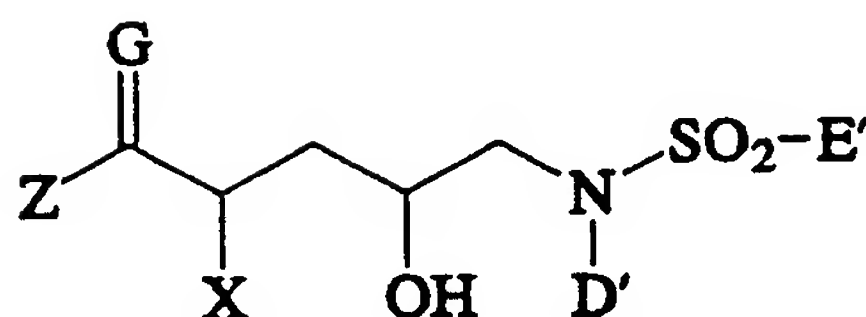


( VII )

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Formula C:

( C )

Formula CI:

( CI )

wherein the variables are as defined for the compounds of formula I with the exception that in formula C, Z is selected from the group consisting of -N(H)A; -N(D)A; -N(H)E; -N(H)C(O)N(D)(E); -N(H)-Het; -Het and -N(D)-Het. The most preferred compounds of formula I are those compounds of formulas VI, VII, and C.

Preferred compounds of formula IV include those compounds having the following definitions for one or more of the below-specified variables:

each D and D' is independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sup>6</sup>;

each E and E' is independently selected from C<sub>5</sub>-C<sub>6</sub> aryl, which may be optionally substituted with R<sup>4</sup>;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

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each Z is independently selected from the group consisting of -N(H)Het; -N(H)A; -N(D)A and -Het;

each Het is independently selected from the group consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered saturated or unsaturated heterocycle, wherein any member of said Het may be optionally substituted with one or more substituents, the same or different, selected from the group consisting of -OR<sup>2</sup>, R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(R<sup>2</sup>)(R<sup>2</sup>) and -S(O)<sub>n</sub>-R<sup>6</sup>;

each X and X' is independently selected from the group consisting of H, -OH and, most preferably, if X and X' are taken together, oxygen;

each A is independently selected from the group consisting of H; -R<sup>1</sup>-Het and -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl; and

each R<sup>1</sup> is independently selected from the group consisting of -C(O)- and -O-C(O)-.

Preferred compounds of formula VI include those compounds having the following definitions for one or more of the below-identified variables:

each D and D' is independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sup>6</sup>;

each X and X' is independently selected from the group consisting of H, OH, and if X and X' are taken together, oxygen;

each E' is independently selected from C<sub>5</sub>-C<sub>6</sub> aryl, which may be optionally substituted with R<sup>4</sup>;

each R<sup>1</sup> is selected from the group consisting of -C(O)- and -O-C(O)-;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

each Z is selected from the group consisting of -N(H)Het; -N(H)A; -N(D)A and -Het;

each Het is independently selected from the group consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered

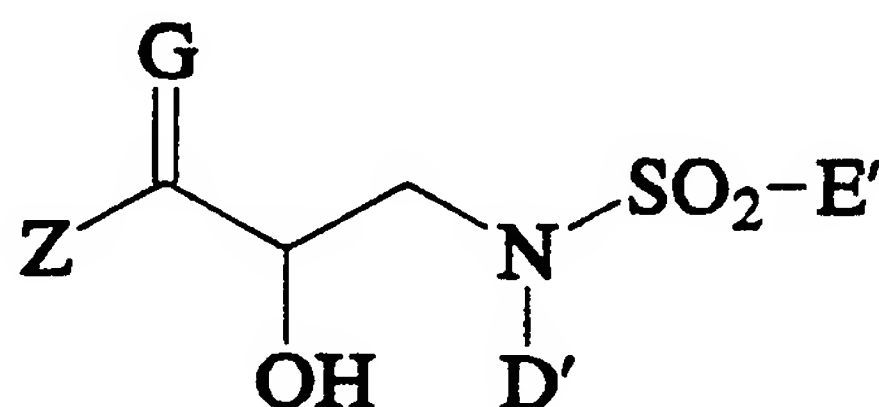
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saturated or unsaturated heterocycle, and wherein any member of said Het may be optionally substituted with one or more substituents, the same or different, selected from the group  
 5 consisting of  $-OR^2$ ,  $R^2$ ,  $-N(R^2)(R^2)$ ,  $-NO_2$ ,  $-C(O)N(R^2)(R^2)$  and  $-S(O)_n-R^6$ ; and

each A is selected from the group consisting of H;  $-R^1$ -Het and  $-R^1-C_1-C_6$  alkyl.

10 Other preferred compounds of formula VI include those compounds of formula CIII:

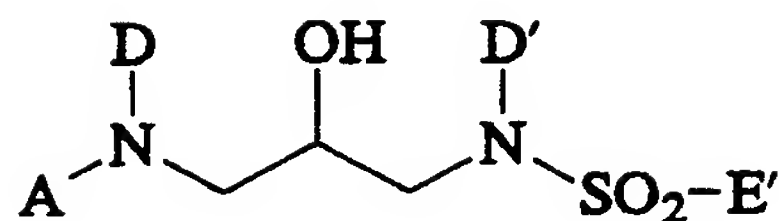
Formula CIII:



( CIII )

wherein the variables are defined as above for the compounds of formula I. Preferred compounds of formula CIII include those compounds having one or more  
 15 variables as defined for preferred compounds of formula VI. In addition, preferred compounds of formula CIII include those compounds having the formula LVIIa:

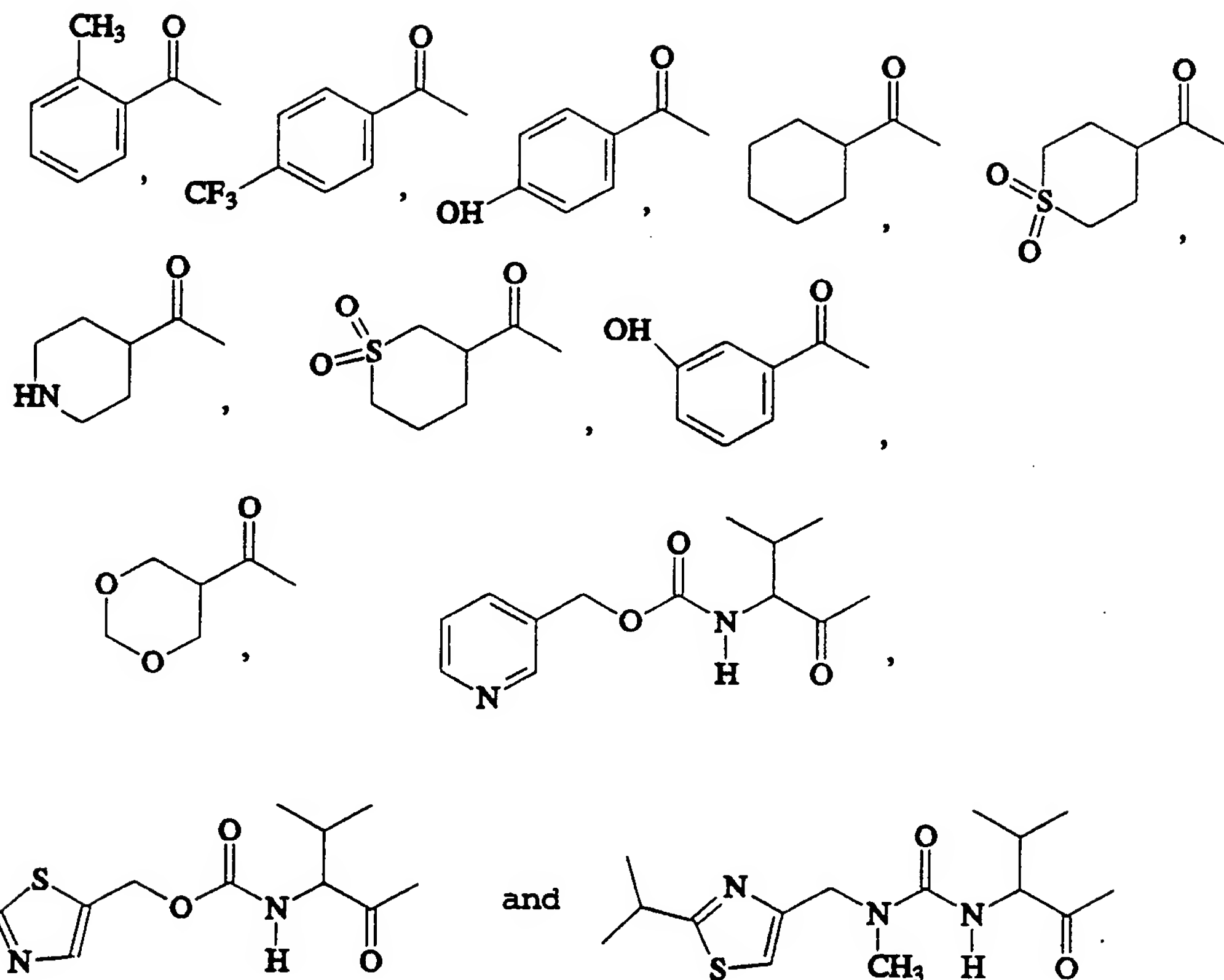
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Formula LVIIa:

( LVIIa )

wherein A is selected from the group consisting of -R<sup>1</sup>-  
Het and -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl substituted with -N(R<sup>2</sup>)-CO-  
N(R<sup>2</sup>)(R<sup>2</sup>) or -N(R<sup>2</sup>)-CO-O-R<sup>2</sup>; R<sup>1</sup> is selected from the  
5 group consisting of -C(O)- and -O-C(O)-; and the other  
variables are defined as above for the compounds of  
formula I. For compounds of formula LVIIa, preferred  
definitions for A include -R<sup>1</sup>-phenyl-R<sup>7</sup>, -R<sup>1</sup>-heterocycle  
and -Val-R<sup>1</sup>-R<sup>2</sup>. More preferred definitions for A  
10 include:

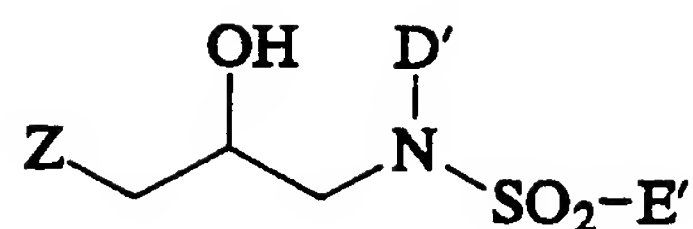
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Preferred D and D' for compounds of formula LVIIa include C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sup>6</sup>.

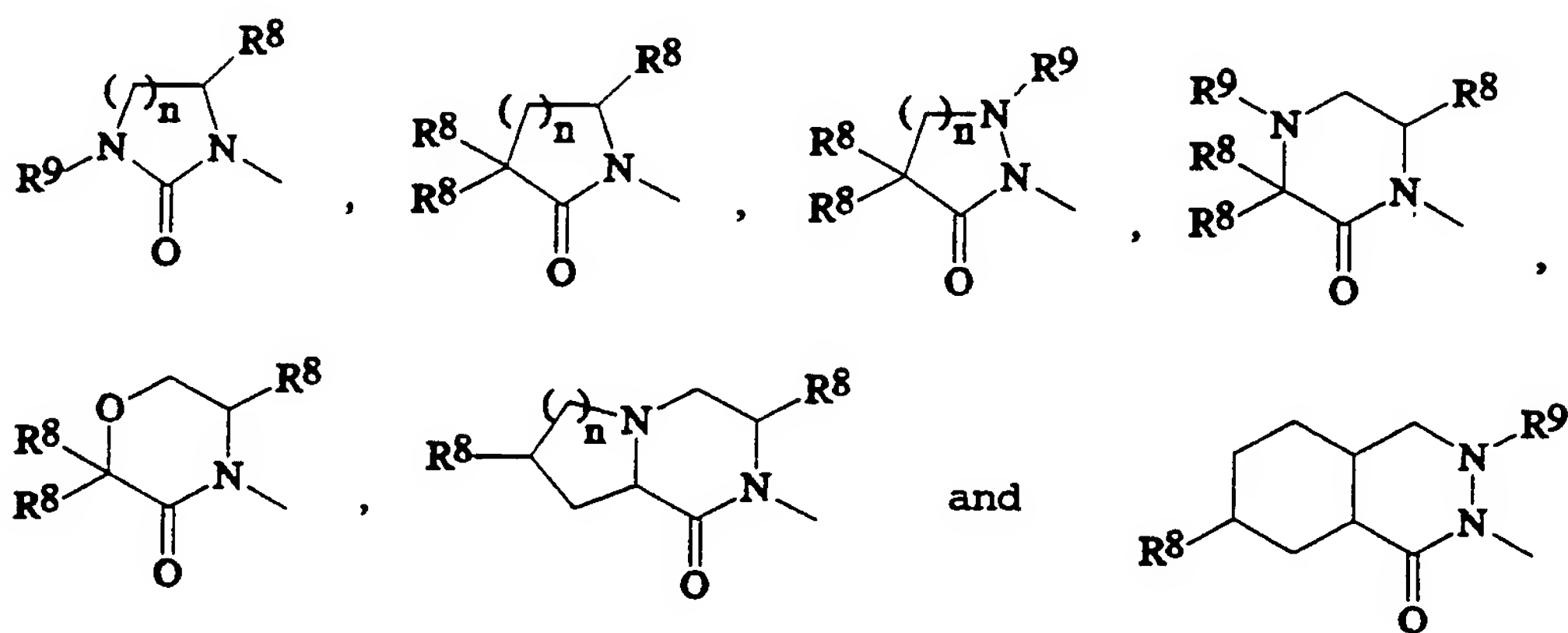
5 Preferred compounds of formula CIII also include those compounds having the formula LVIIb:

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Formula LVIIb:

( LVIIb )

wherein Z is selected from the group consisting of:



and wherein R<sup>8</sup> is selected from the group consisting of R<sup>2</sup>, -N-C(O)-O-R<sup>2</sup> and -N-C(O)-R<sup>2</sup>; R<sup>9</sup> is selected from the group consisting of R<sup>2</sup>, -C(O)-O-R<sup>2</sup> and -C(O)-R<sup>2</sup> and R<sup>2</sup> is as defined above for compounds of formula I.

For compounds of formula LVIIb, preferred D and D' are C<sub>1</sub>-C<sub>6</sub> alkyl which may be optionally substituted with R<sup>6</sup>.

Preferred compounds of formula VII include those compounds having the following definitions for one or more of the below-specified variables:

each D and D' is C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sup>6</sup>;

G is H<sub>2</sub>;

- 27 -

each X and X' is independently selected from the group consisting of H, OH, and if X and X' are taken together, oxygen;

each E' is independently selected from C<sub>5</sub>-C<sub>6</sub> aryl, which may be optionally substituted with R<sup>4</sup>;

each R<sup>1</sup> is selected from the group consisting of -C(O)- and -O-C(O)-;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

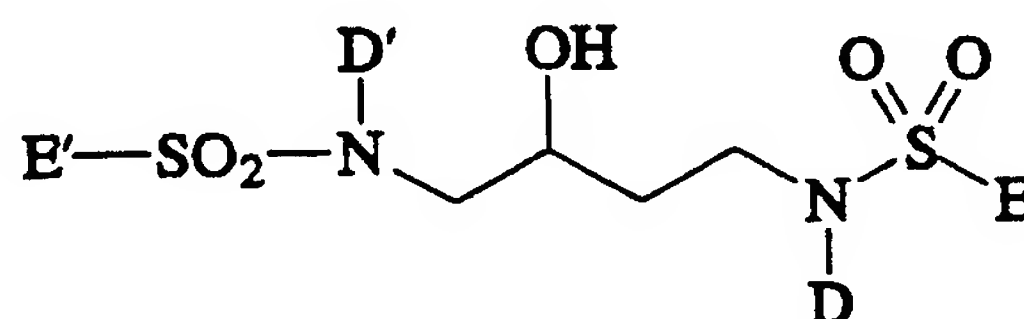
each Z is selected from the group consisting of -N(H)Het; -N(H)A; -N(D)SO<sub>2</sub>E; -N(D)A and -Het; and more preferably from either -N(D)SO<sub>2</sub>E or -N(H)Het;

each Het is independently selected from the group consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered saturated or unsaturated heterocycle, and wherein any member of said Het may be optionally substituted with one or more substituents, the same or different, selected from the group consisting of -OR<sup>2</sup>, R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(R<sup>2</sup>)(R<sup>2</sup>) and -S(O)<sub>n</sub>-R<sup>6</sup>; and

each A is selected from the group consisting of H; -R<sup>1</sup>-Het and -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl.

Other preferred compounds of formula VII are those compounds having the structure of formula CIV:

Formula CIV:



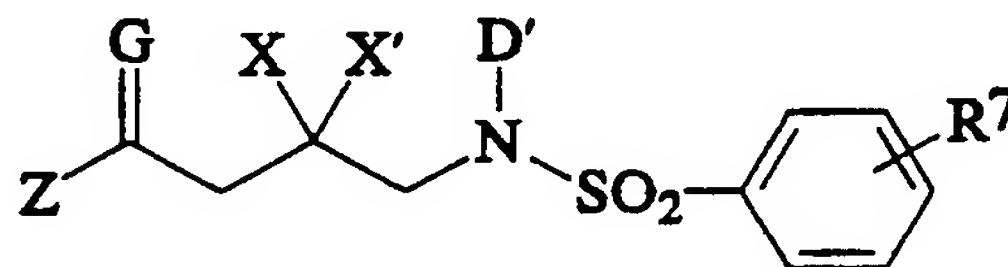
( CIV )

wherein the variables are defined as above for the compounds of formula VII.

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Still other preferred compounds of formula VII are those compounds having the structure of formula LXII:

Formula LXII:



( LXII )

5 wherein the variables are defined as above for compounds of formula I and  $R^7$  is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>. Preferred compounds of formula LXII include those  
10 compounds having one or more variables as defined for preferred compounds of formula VII.

Preferred compounds of formula C include those compounds having each Z is selected from the group consisting of -N(H)Het; -N(H)A; -N(D)A and -Het;  
15 and one or more variables as defined for preferred compounds of formula VI.

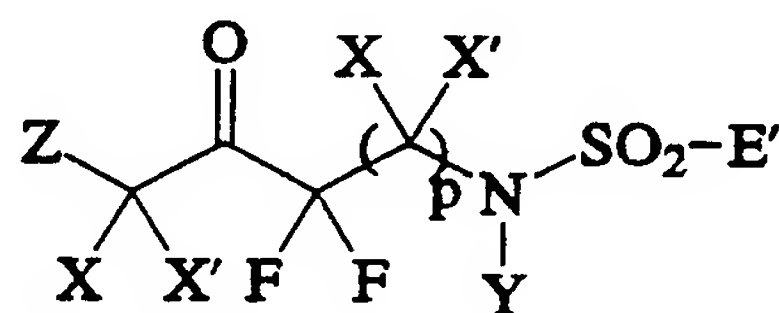
More preferred compounds of formula C include those compounds wherein G is H<sub>2</sub>, X is -OH or H, and X' is -OH or H.

20 Preferred compounds of formula CI include those compounds wherein X is a C<sub>1</sub> alkyl substituted with R<sup>6</sup> and D' is a C<sub>1</sub>-C<sub>4</sub> alkyl optionally substituted with R<sup>6</sup>. Most preferably, X is benzyl and D' is i-Bu or cyclopentylmethyl.

- 29 -

Preferred compounds of formula II include those compounds wherein X and X' on the carbon adjacent to the backbone carbon bearing Z, taken together, are oxygen. Other preferred compounds of formula II are those compounds having the structure of formula VIII:

Formula VIII:



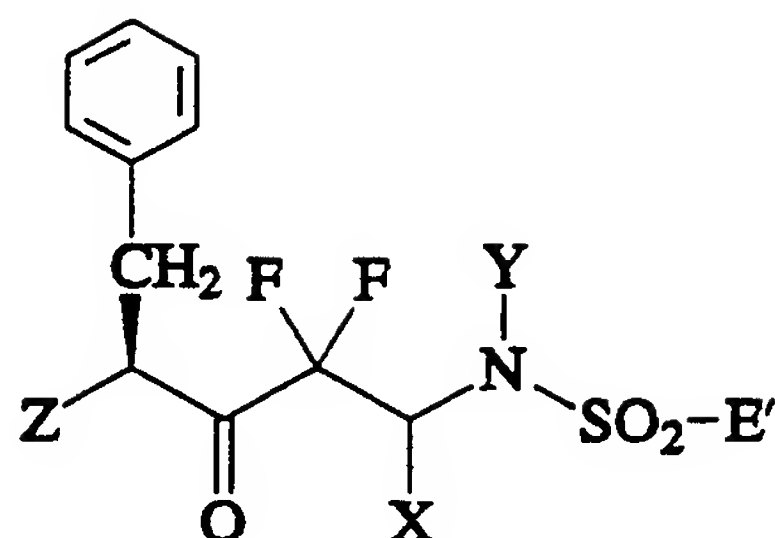
( VIII )

wherein the variables are as defined above for compounds of formula II.

Preferred compounds of formula VIII include those compounds wherein one or more of the variables are defined as follows: on the backbone carbon bearing Z, X is H and X' is D; on the backbone carbon adjacent to N-Y, X and X' are independently selected from D, and preferably from C<sub>1</sub>-C<sub>6</sub> alkyl and H, and most preferably both are H; Y is selected from D, preferably from C<sub>1</sub>-C<sub>6</sub> alkyl and H; and E is a C<sub>6</sub>-C<sub>10</sub> aryl optionally substituted with one or two substituents, the same or different, selected from -OH, -OCH<sub>3</sub>, and -NH<sub>2</sub> and Z is selected from (3S)-THF-OC(O)NH- or 5-(1,3-dioxanyl)-OC(O)NH-.

Other preferred compounds of formula VIII are those compounds having the structure of formula CV:

- 30 -

Formula CV:

( CV )

wherein the variables are as defined above for compounds of formula II. Preferred compounds of formula CV include those compounds where X and Y are independently selected from the group consisting of H or C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sup>6</sup>; and Z is selected from the group consisting of -N(H) (A) or -N(D) (A).

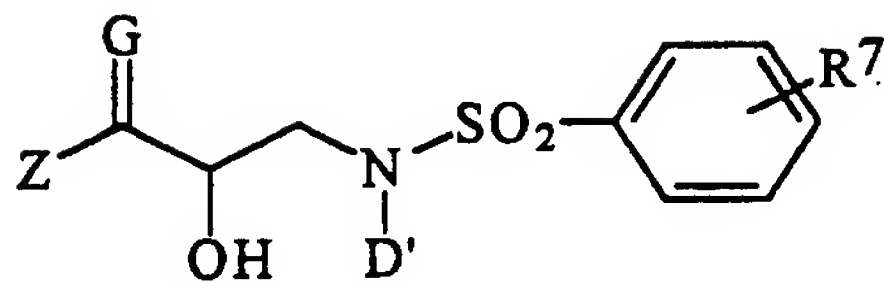
Preferred sulfonamides of this invention of formulas I and II include the specific compounds contained in Tables 1 through 8. Preferred compounds are those which appear in Tables 1, 5, 6, and 7. Although particular -phenyl-R<sup>7</sup> variables are specified in these tables, this invention expressly encompasses the specific compounds shown having any -phenyl-R<sup>7</sup>, as defined above. In such compounds, preferably, at least three, and more preferably four, of the R<sup>7</sup> substituents are H.

- 31 -

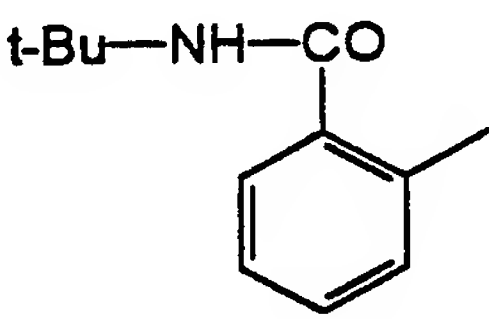
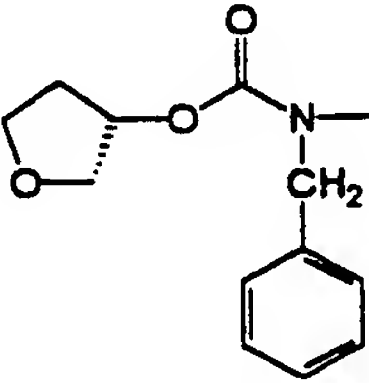
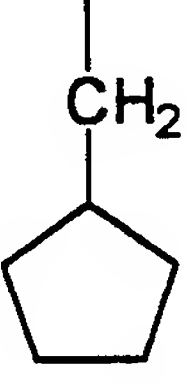
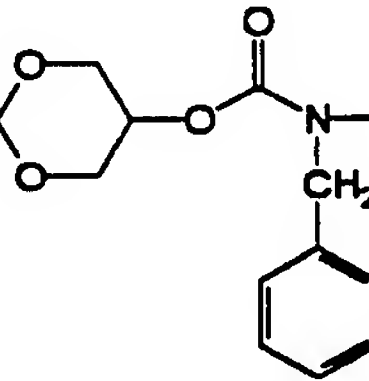
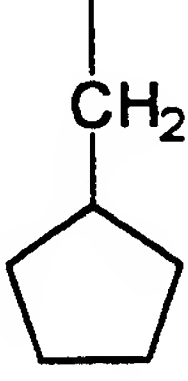
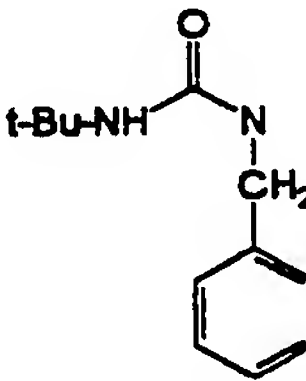
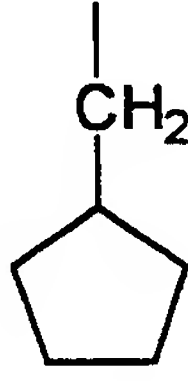
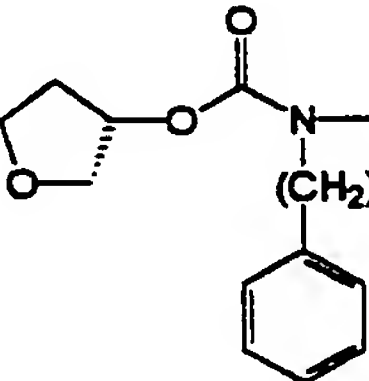
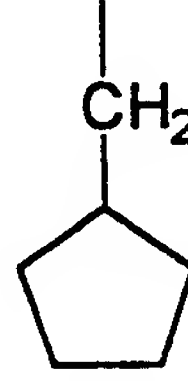
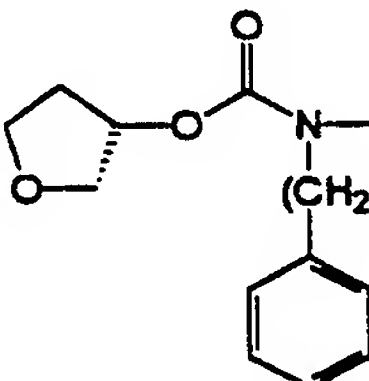
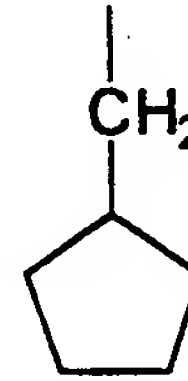
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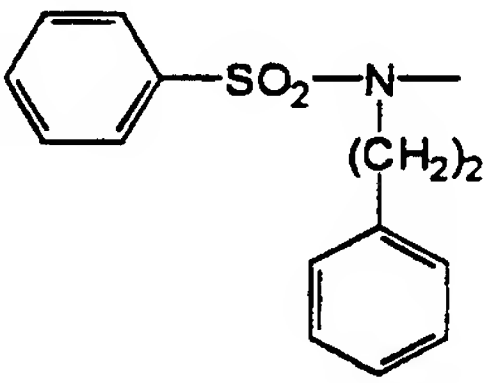
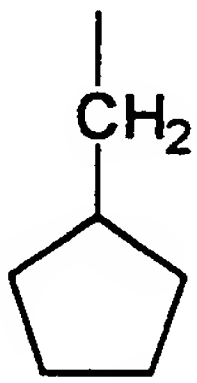
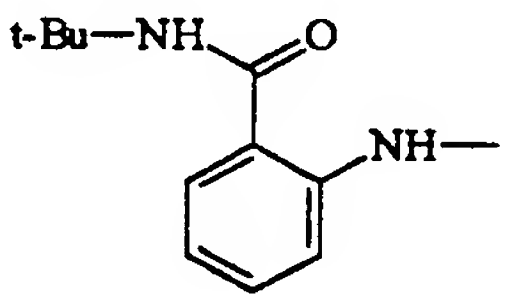
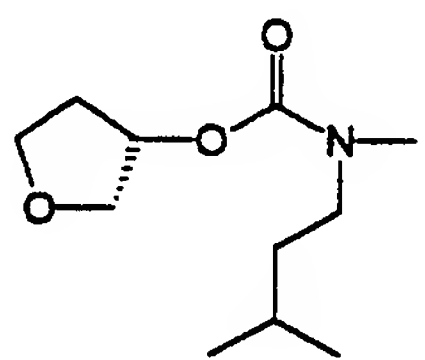
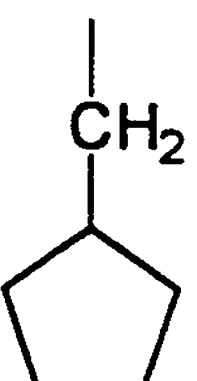
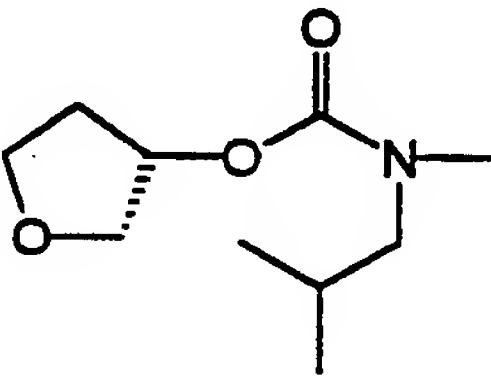
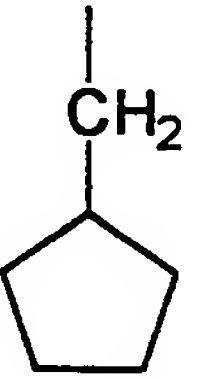
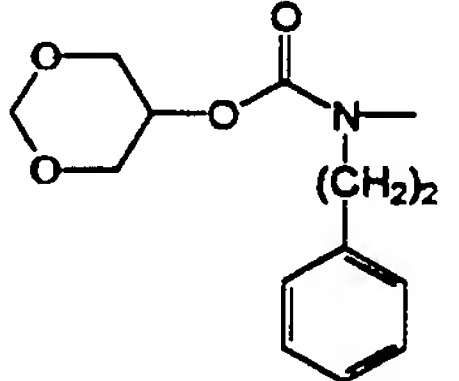
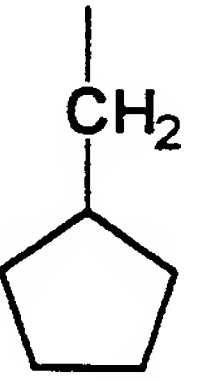
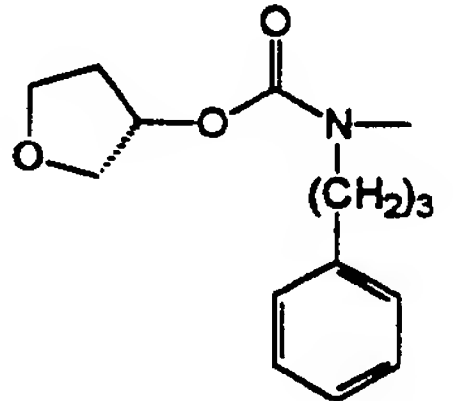
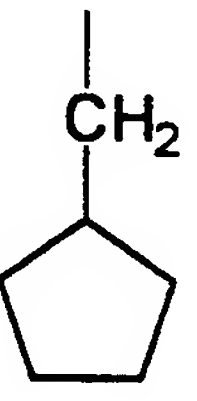
	Table 1: preferred compounds of Formula CIII
	Table 2: preferred compounds of Formula LVIIb
5	Table 3: preferred compounds of Formula CV
	Table 4: preferred compounds of Formula IV
	Table 5: preferred compounds of Formula LXII
	Table 6: preferred compounds of Formula CIV
	Table 7: preferred compounds of Formula C
10	Table 8: preferred compounds of Formula CI

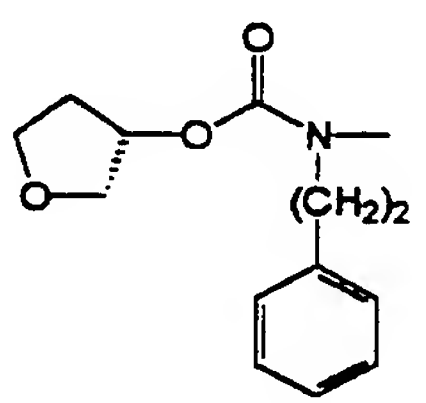
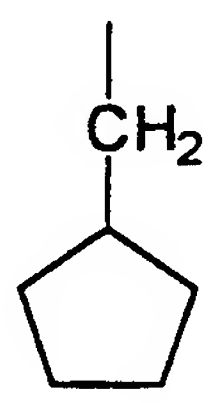
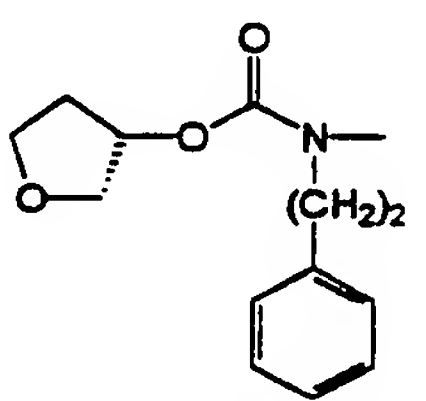
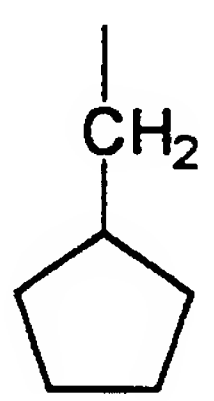
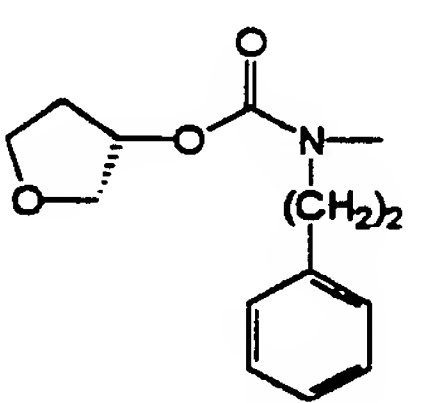
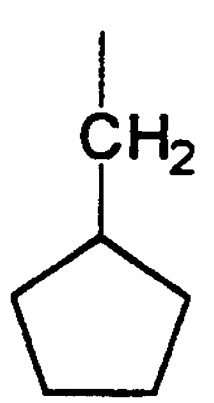
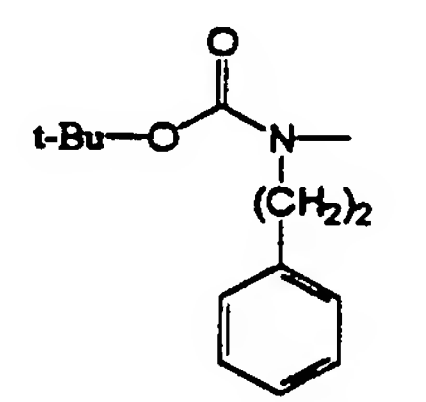
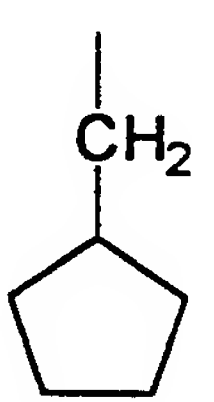
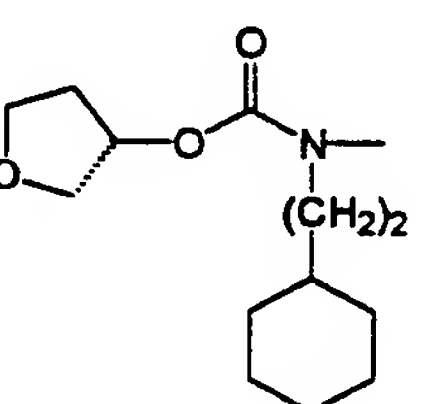
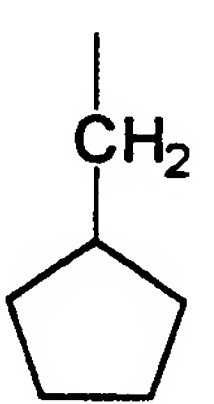
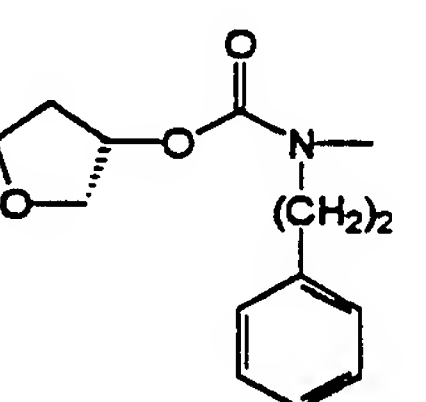
TABLE 1

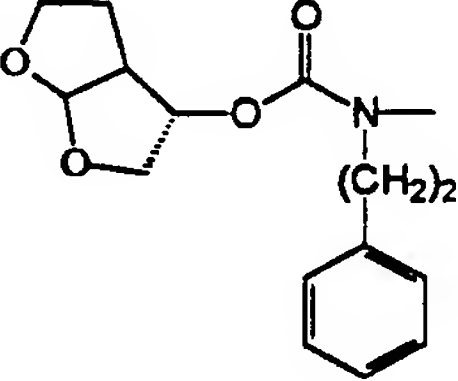
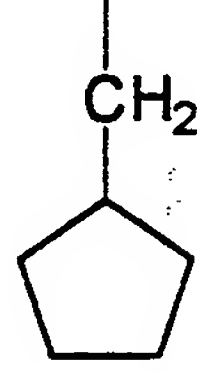
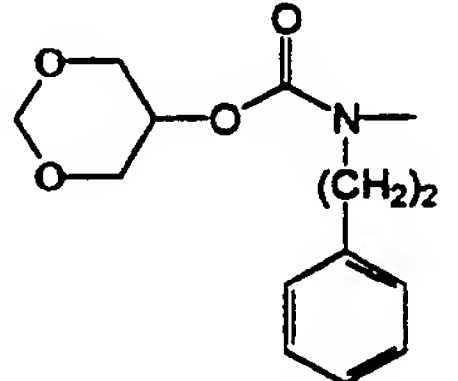
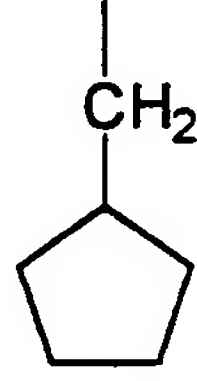
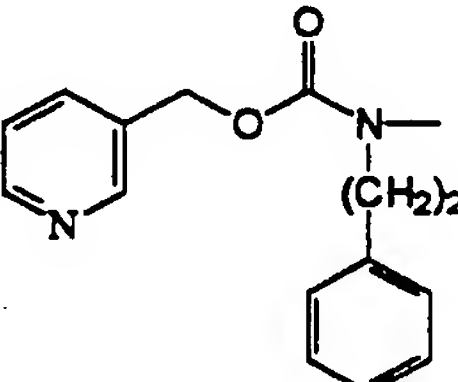
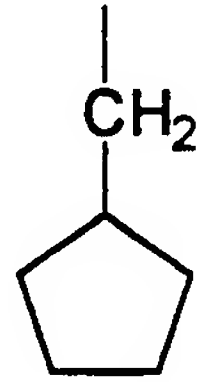
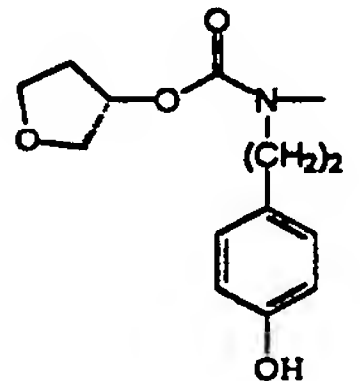
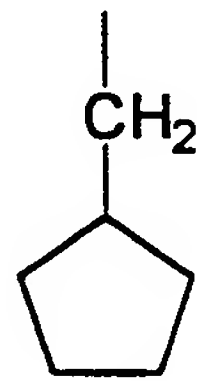
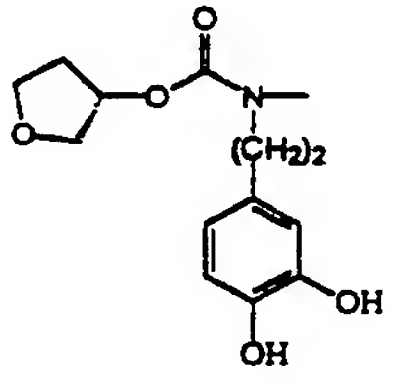
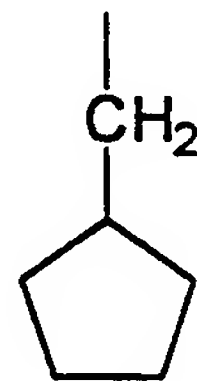
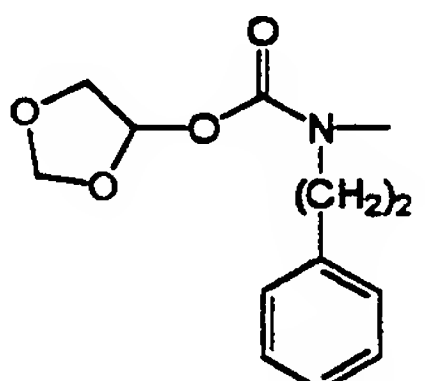
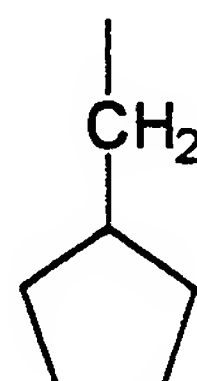


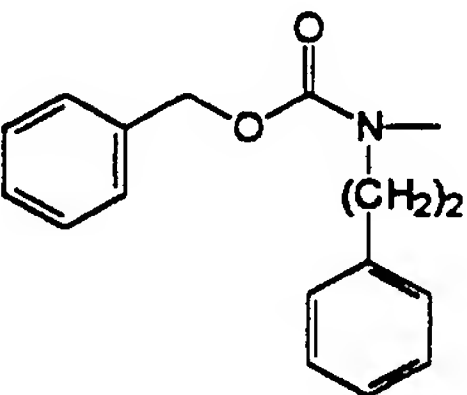
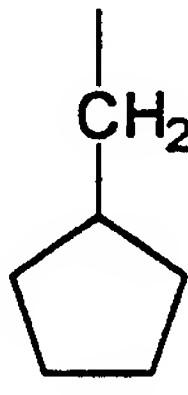
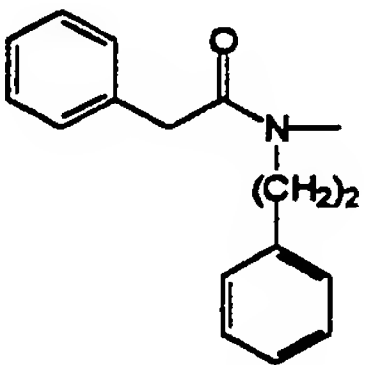
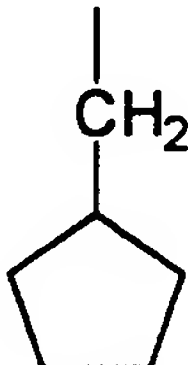
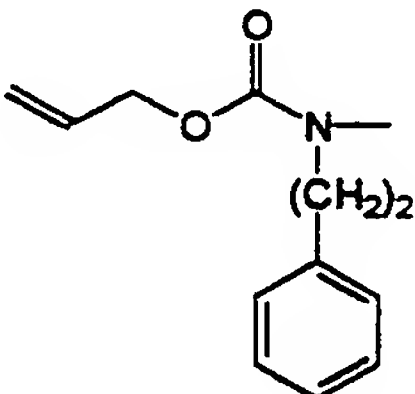
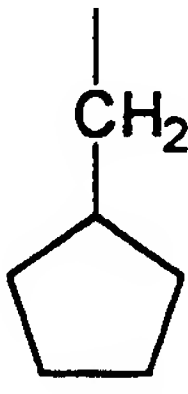
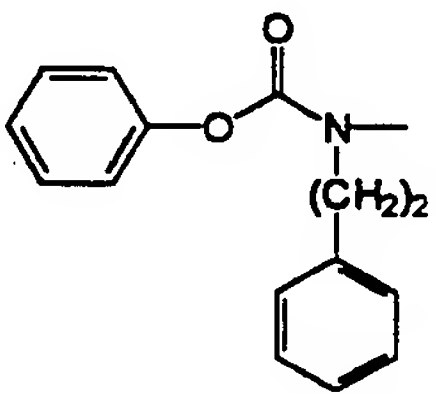
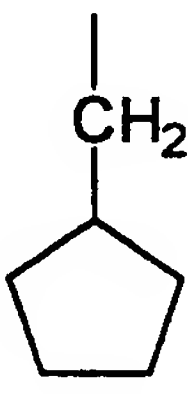
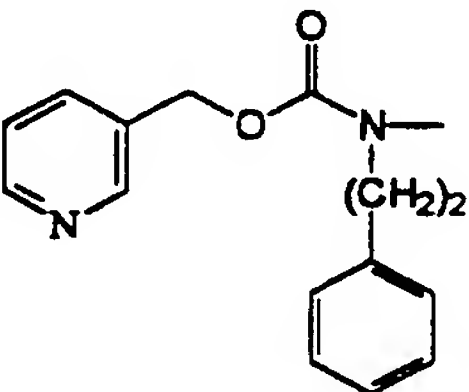
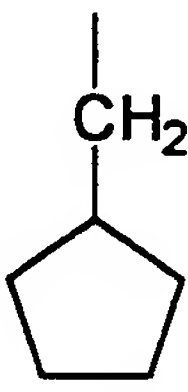
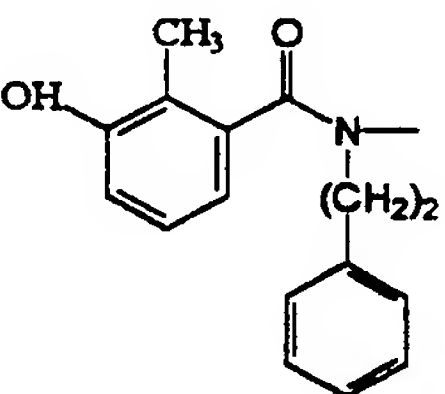
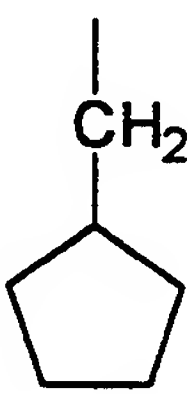
COMPOUND	OH	Z	G	D'	R <sup>7</sup>
XVI	R,S		H <sub>2</sub>	i-Bu	4-OCH <sub>3</sub>
XVII	R,S		H <sub>2</sub>	i-Bu	4-OCH <sub>3</sub>
XVIII	R,S		O	i-Bu	4-OCH <sub>3</sub>
XIX	R,S		H <sub>2</sub>	i-Bu	4-OCH <sub>3</sub>

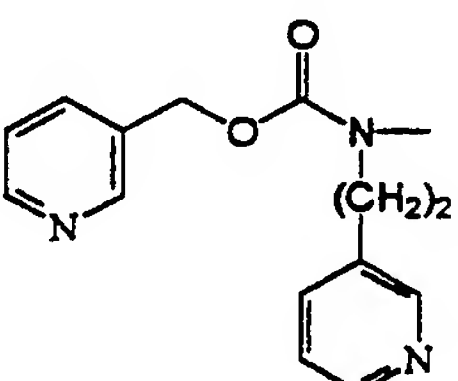
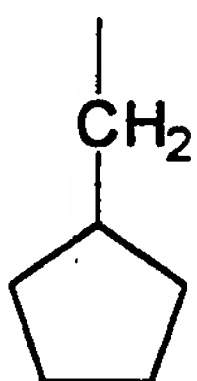
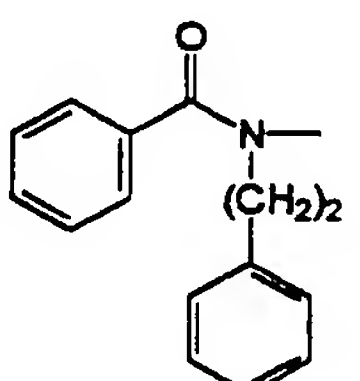
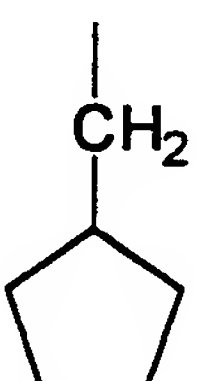
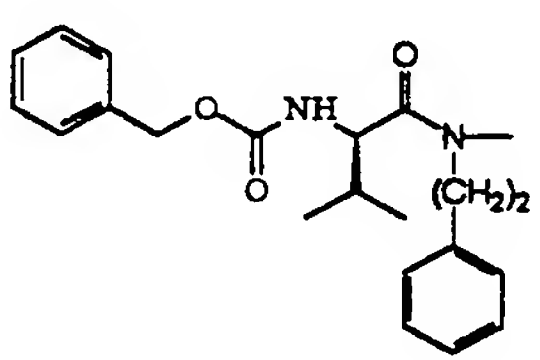
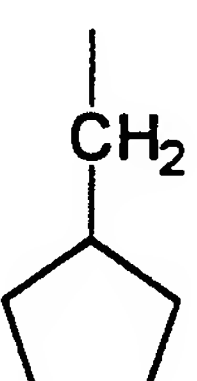
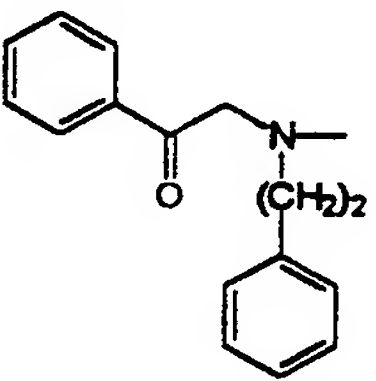
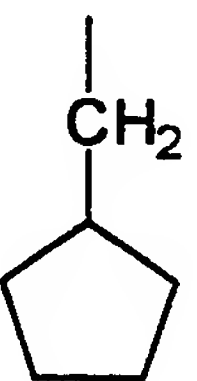
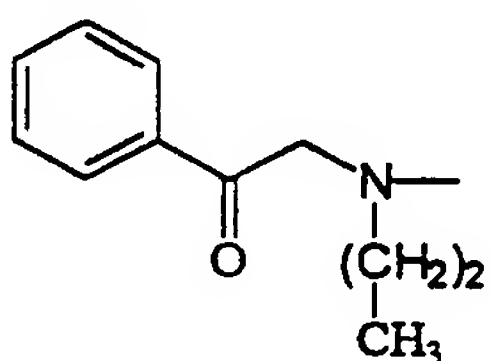
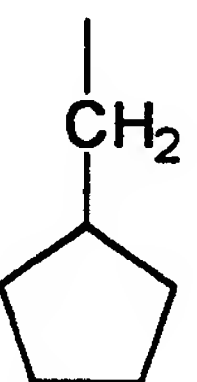
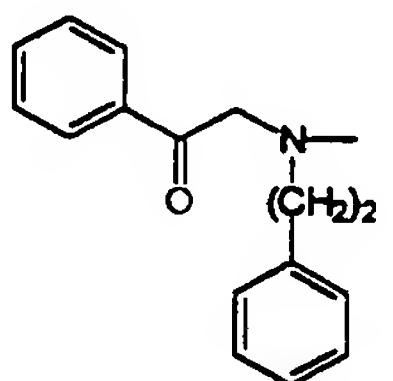
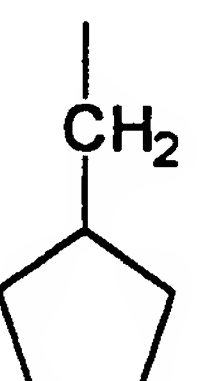
XX	R,S	 <chem>CC1=CC=C(C(=C1)C(=O)NC(C)(C)C)</chem>	H <sub>2</sub>	i-Bu	4-OCH <sub>3</sub>
XXI	R,S	 <chem>COc1ccc(cc1)CN(C)C(=O)O[C@H]2CC[C@H](C2)c3ccccc3</chem>	H <sub>2</sub>	 <chem>CC1CCCC1</chem>	4-OCH <sub>3</sub>
LXV	R,S	 <chem>COc1ccc(cc1)CN(C)C(=O)O[C@H]2CC[C@H](C2)c3ccccc3</chem>	H <sub>2</sub>	 <chem>CC1CCCC1</chem>	4-OCH <sub>3</sub>
XXII	R,S	 <chem>CC1=CC=C(C=C1)CN(C)C(=O)NC(C)(C)C</chem>	H <sub>2</sub>	 <chem>CC1CCCC1</chem>	4-OCH <sub>3</sub>
1000	R	 <chem>COc1ccc(cc1)CN(C)C(=O)O[C@H]2CC[C@H](C2)c3ccccc3</chem>	H <sub>2</sub>	 <chem>CC1CCCC1</chem>	4-OCH <sub>3</sub>
1001	S	 <chem>COc1ccc(cc1)CN(C)C(=O)O[C@H]2CC[C@H](C2)c3ccccc3</chem>	H <sub>2</sub>	 <chem>CC1CCCC1</chem>	4-OCH <sub>3</sub>

XXIV	R,S		H <sub>2</sub>		4-OCH <sub>3</sub>
1002	R,S		H <sub>2</sub>	i-Bu	4-OCH <sub>3</sub>
1003	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1004	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1005	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1006	S		H <sub>2</sub>		4-OCH <sub>3</sub>

1007	S		H <sub>2</sub>		4-OH
1008	S		H <sub>2</sub>		4-NH <sub>2</sub>
1009	S		H <sub>2</sub>		3-NH <sub>2</sub>
1010	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1011	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1012	S		H <sub>2</sub>	i-Bu	3-NH <sub>2</sub>

1013	S		H <sub>2</sub>		3-NH <sub>2</sub>
1014	S		H <sub>2</sub>		3-NH <sub>2</sub>
1015	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1016	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1017	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1018	S		H <sub>2</sub>		4-OCH <sub>3</sub>

1019	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1020	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1021	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1022	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1023	S		H <sub>2</sub>		H
1024	S		H <sub>2</sub>		4-OCH <sub>3</sub>

1025	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1026	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1027	R,S		H <sub>2</sub>		4-OCH <sub>3</sub>
1028	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1029	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1043	S		H <sub>2</sub>		3-NH <sub>2</sub>

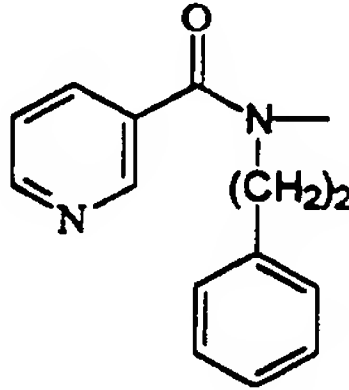
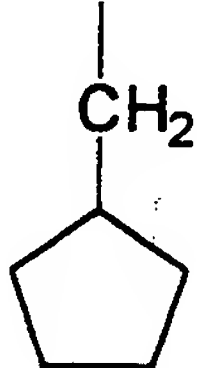
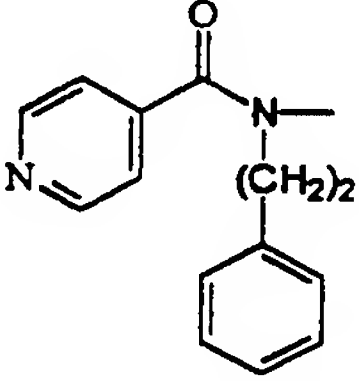
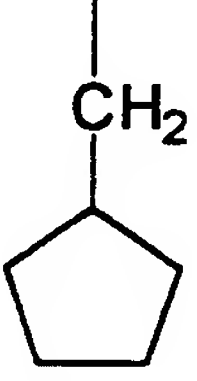
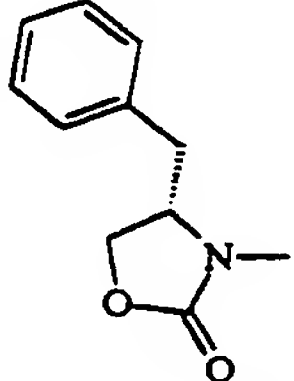
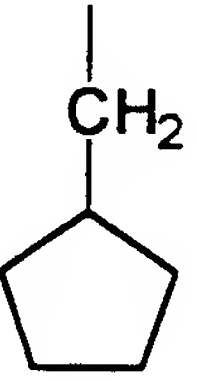
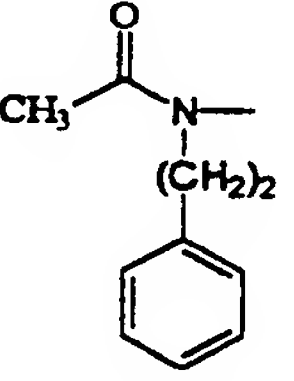
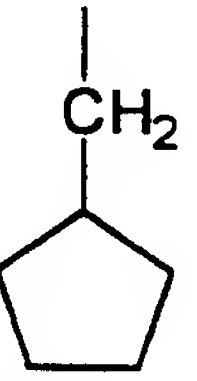
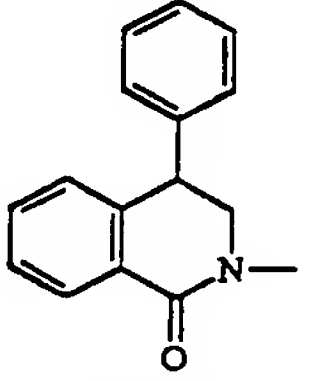
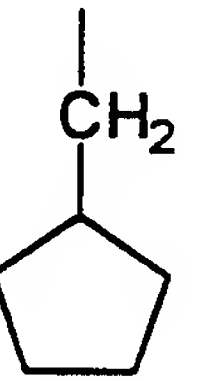
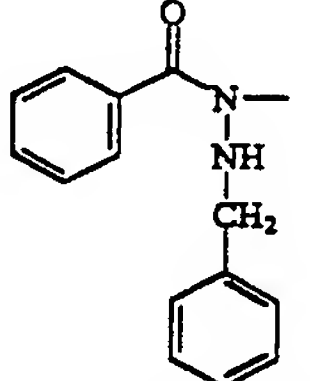
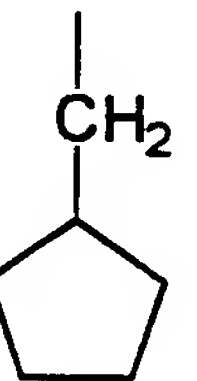
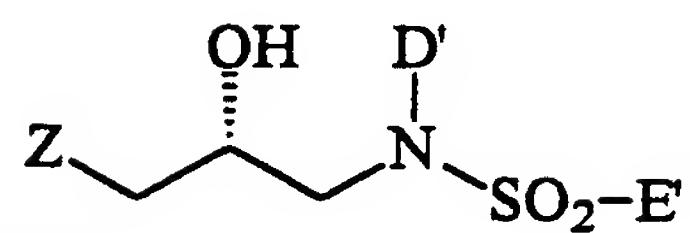
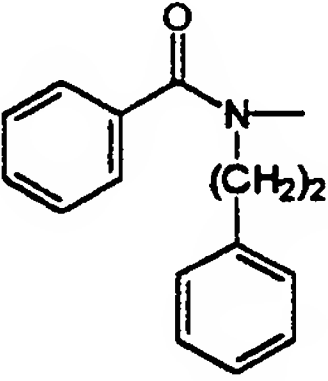
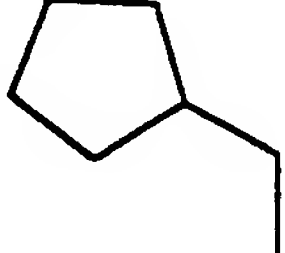
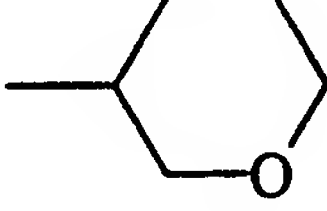
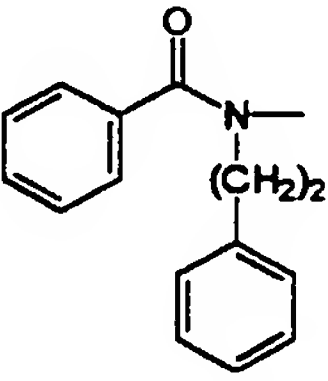
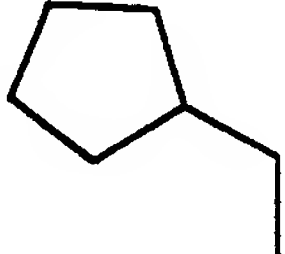
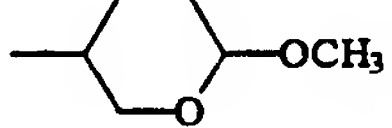
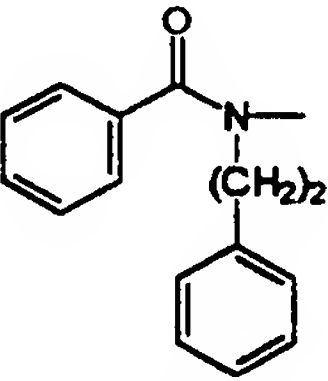
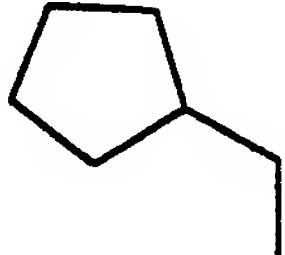
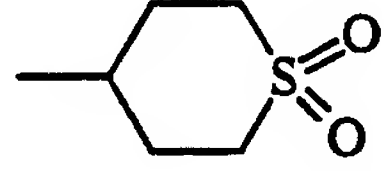
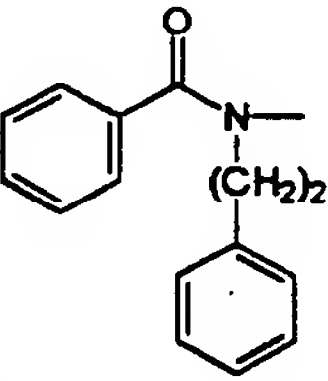
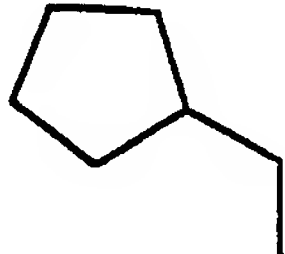
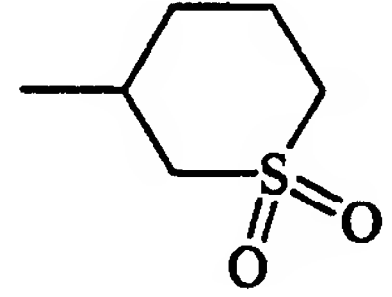
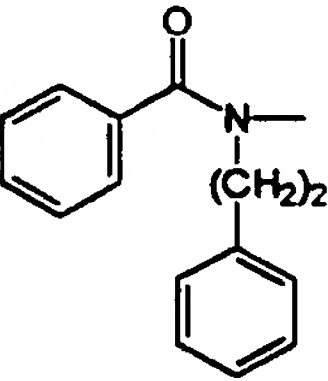
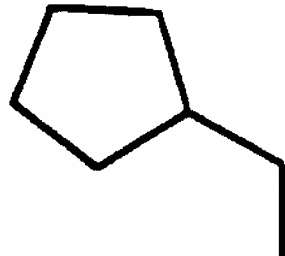
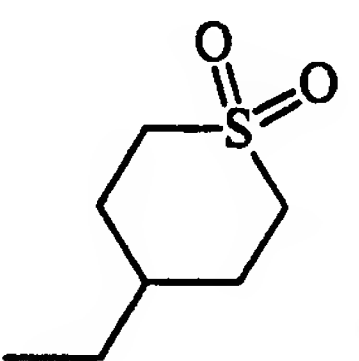
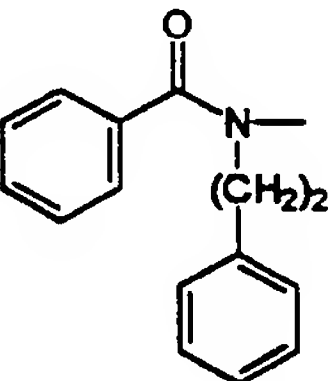
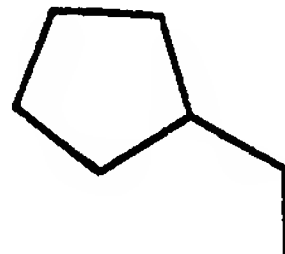
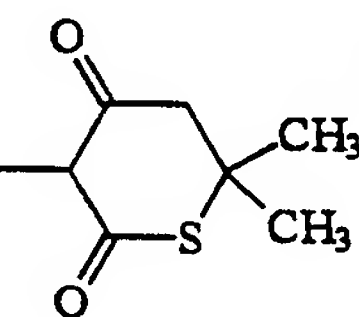
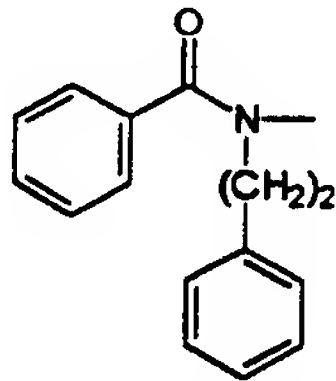
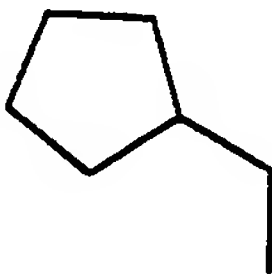
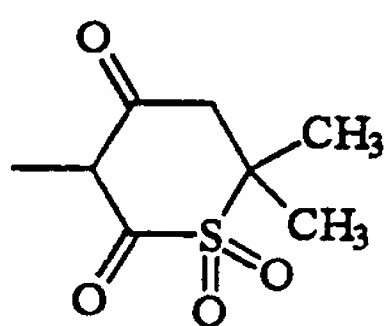
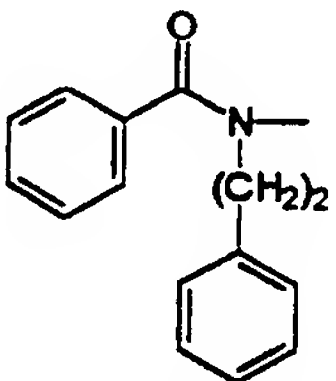
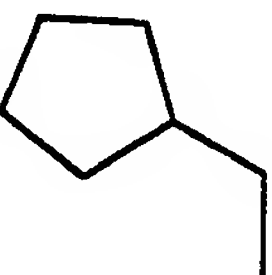
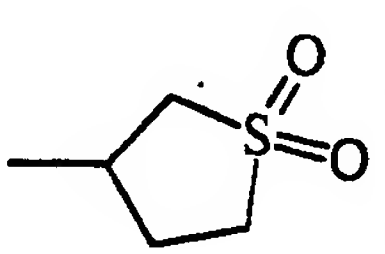
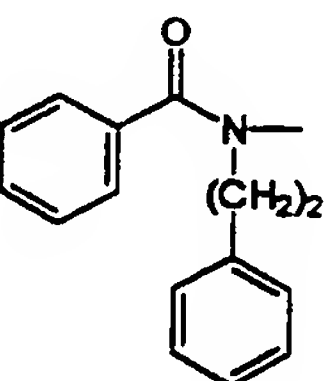
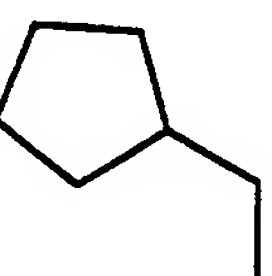
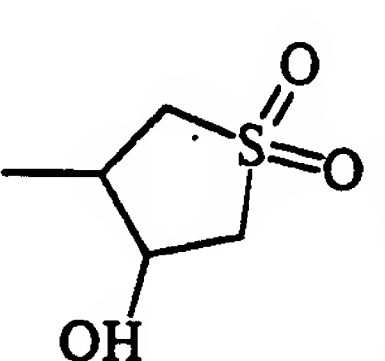
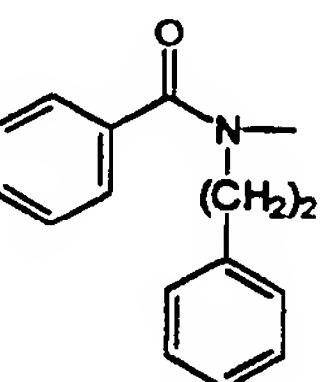
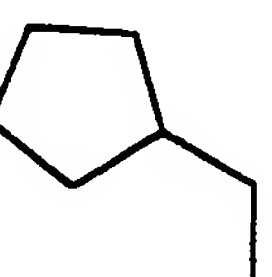
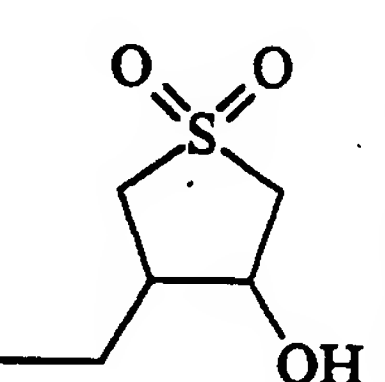
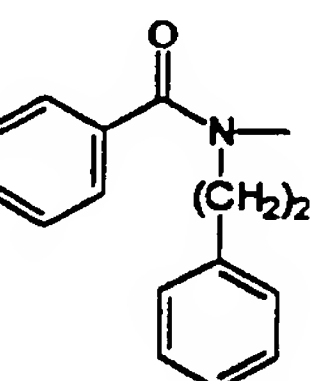
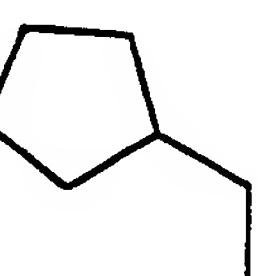
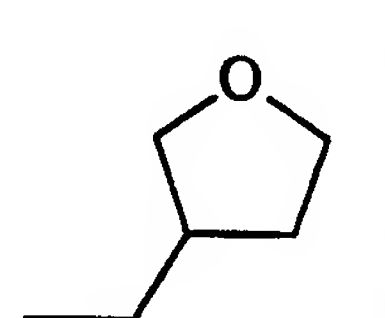
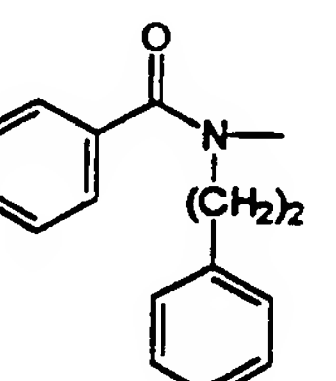
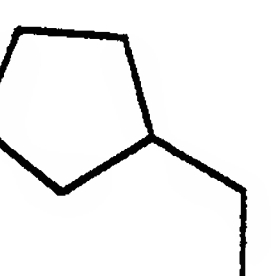
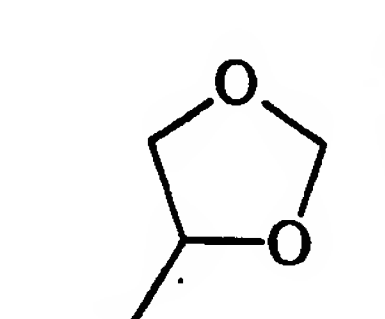
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1046	R,S		H <sub>2</sub>		4-OCH <sub>3</sub>
1047	S		H <sub>2</sub>		4-OCH <sub>3</sub>
1048	R,S		H <sub>2</sub>		4-OCH <sub>3</sub>
1125	R,S		H <sub>2</sub>		3-NH <sub>2</sub>

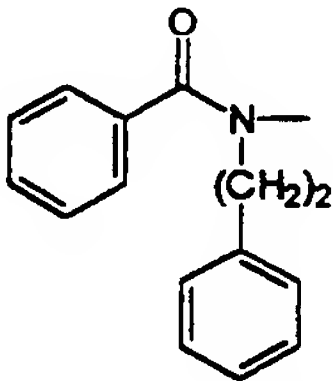
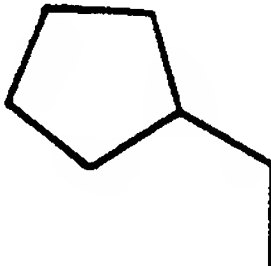
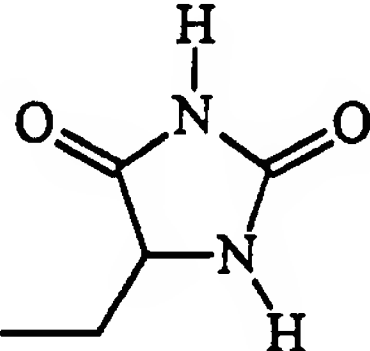
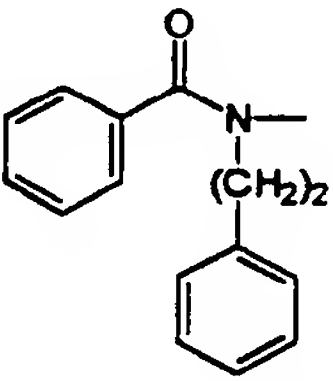
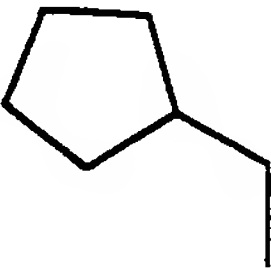
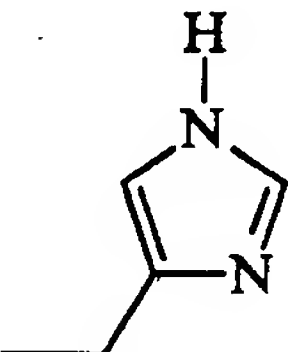
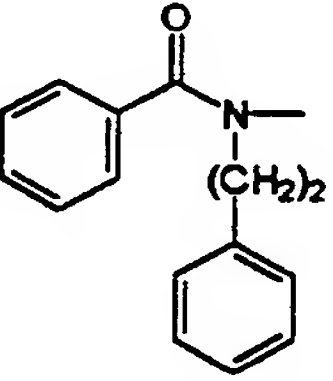
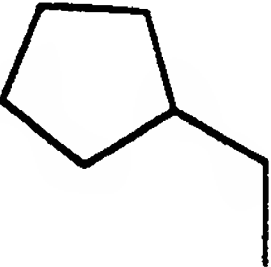
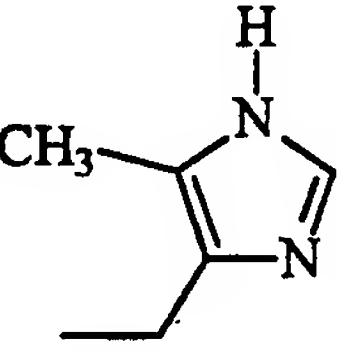
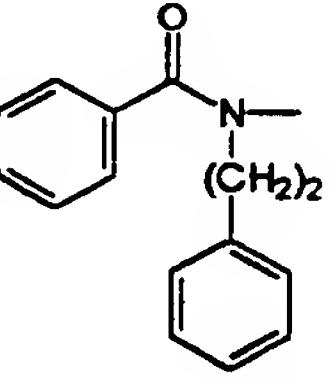
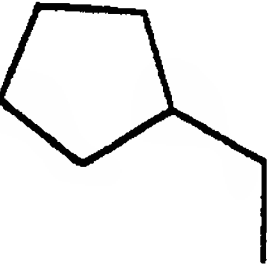
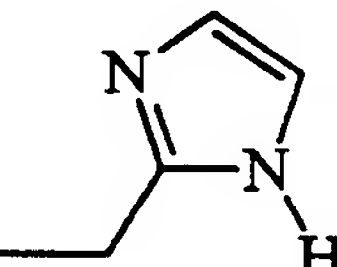
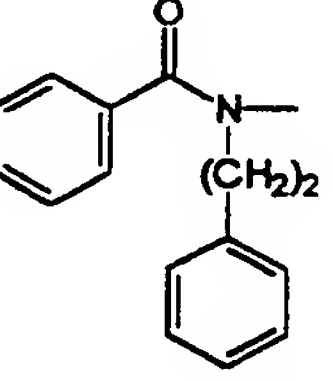
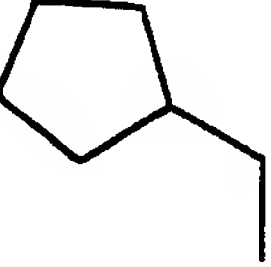
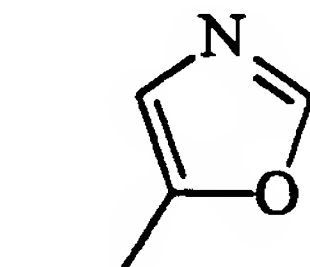
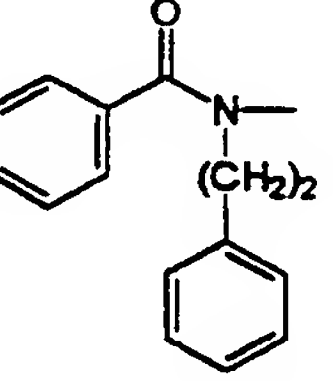
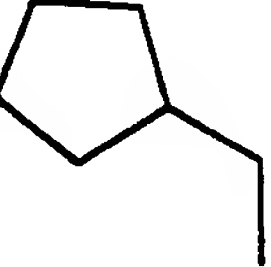
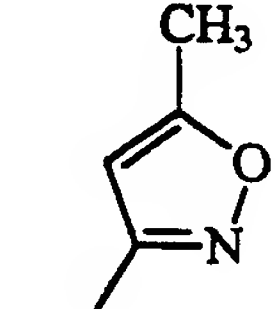
TABLE 2

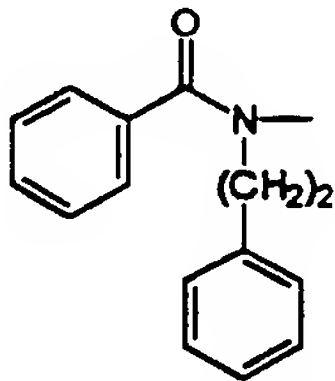
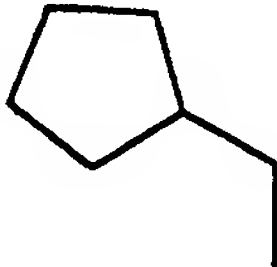
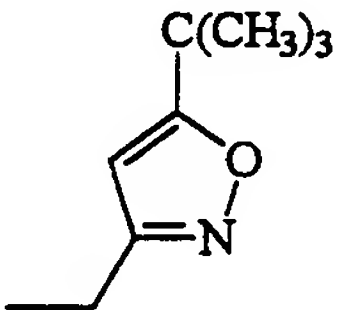
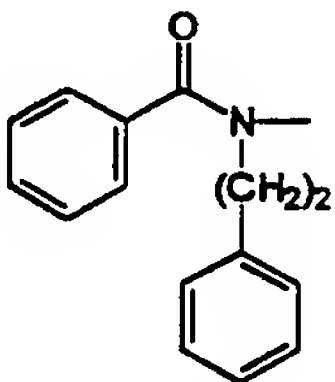
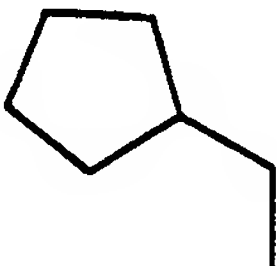
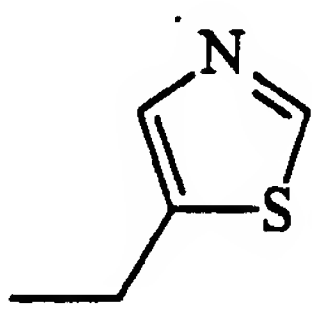
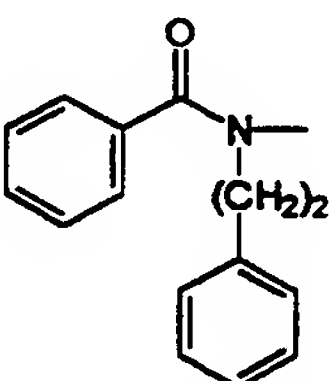
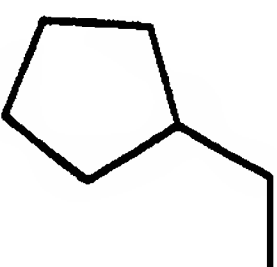
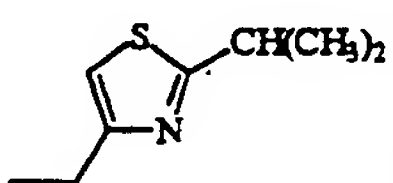
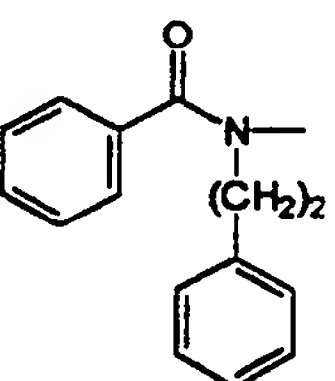
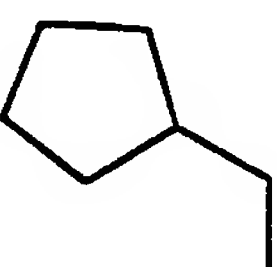
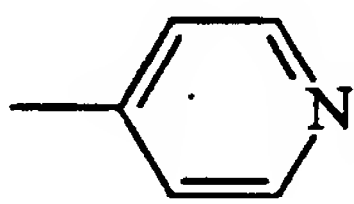
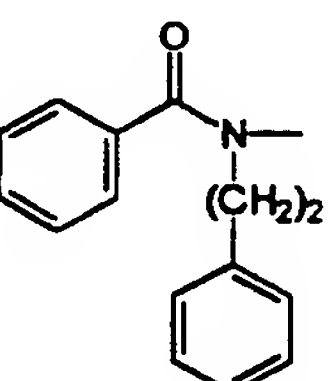
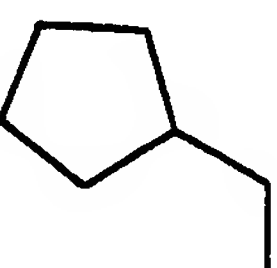
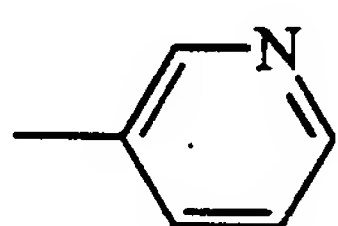
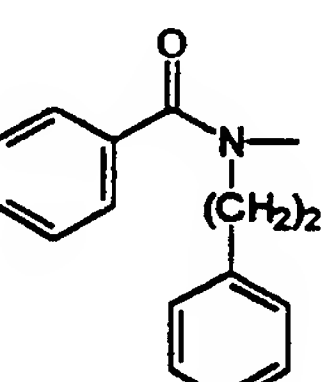
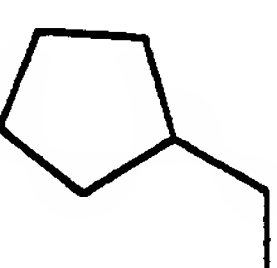
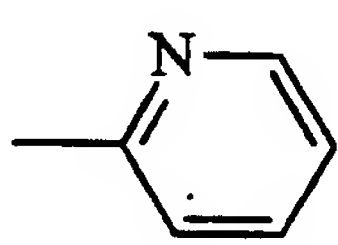


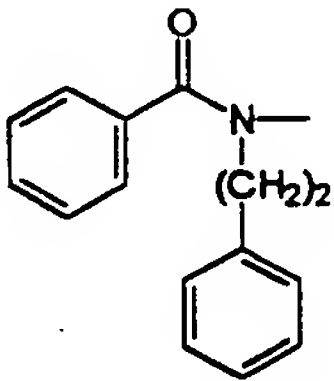
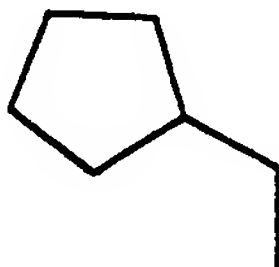
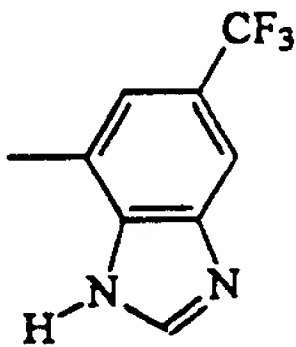
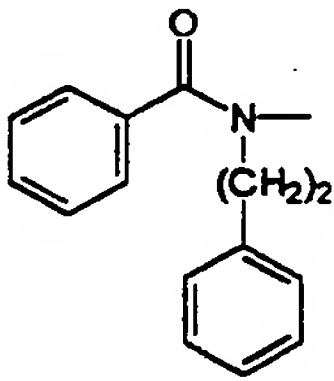
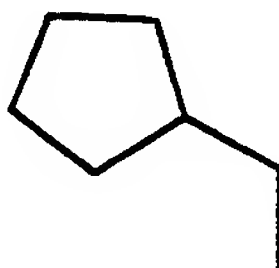
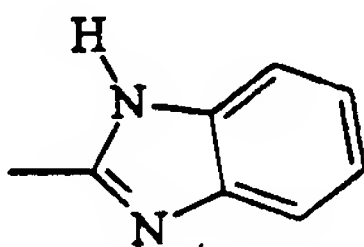
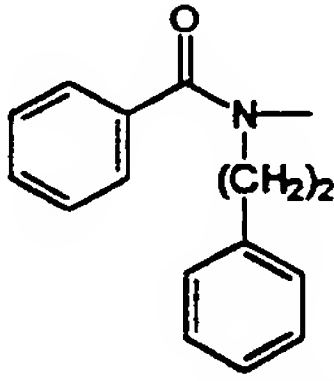
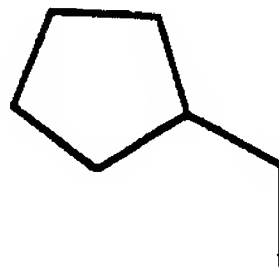
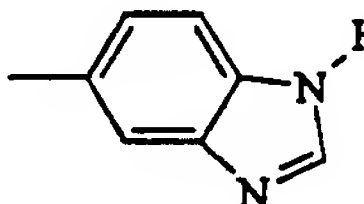
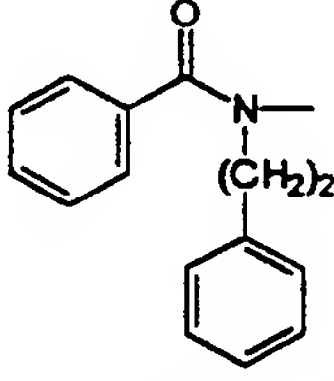
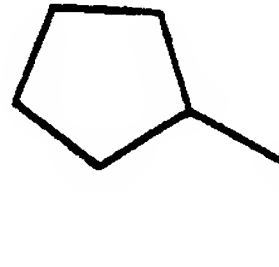
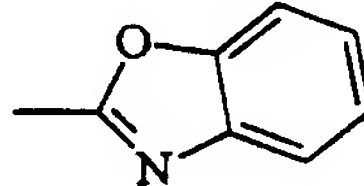
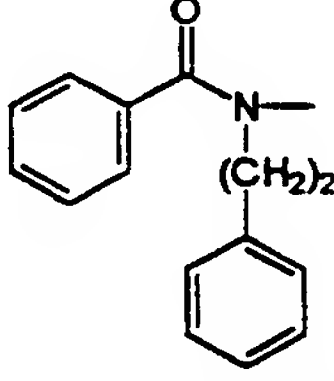
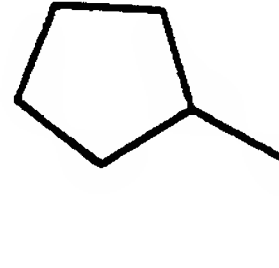
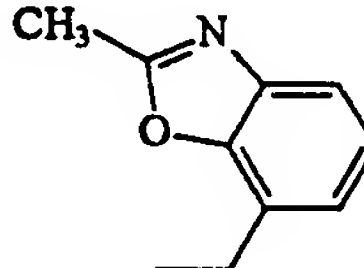
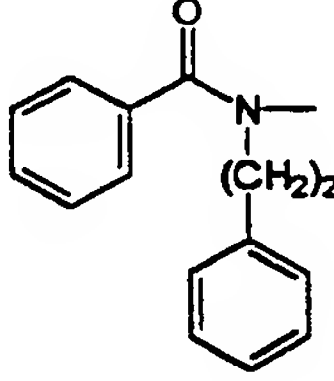
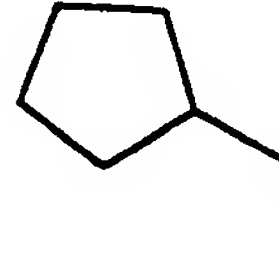
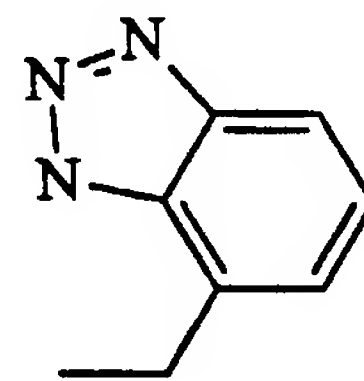
COMPOUND	Z	D'	E'
1050			
1051			t-Bu
1052			
1053			

1054			
1055			
1056			
1057			
1058			
1059			

1060			
1061			
1062			
1063			
1064			
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1078			
1079			
1080			
1081			
1082			
1083			

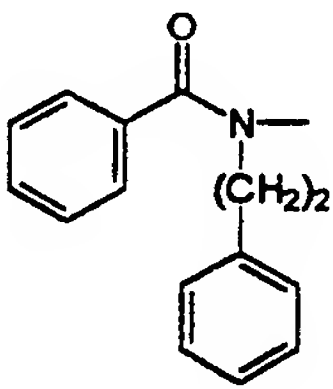
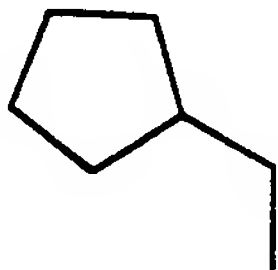
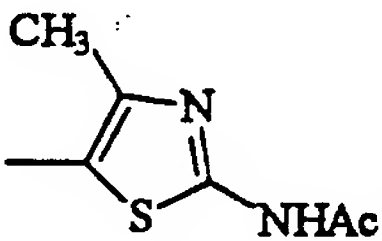
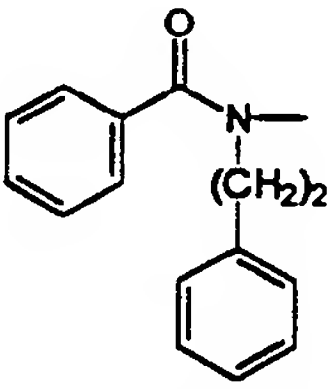
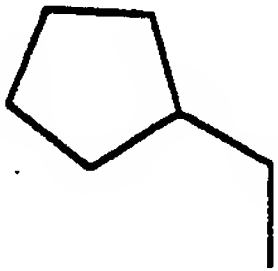
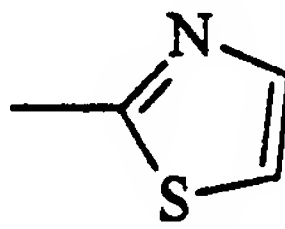
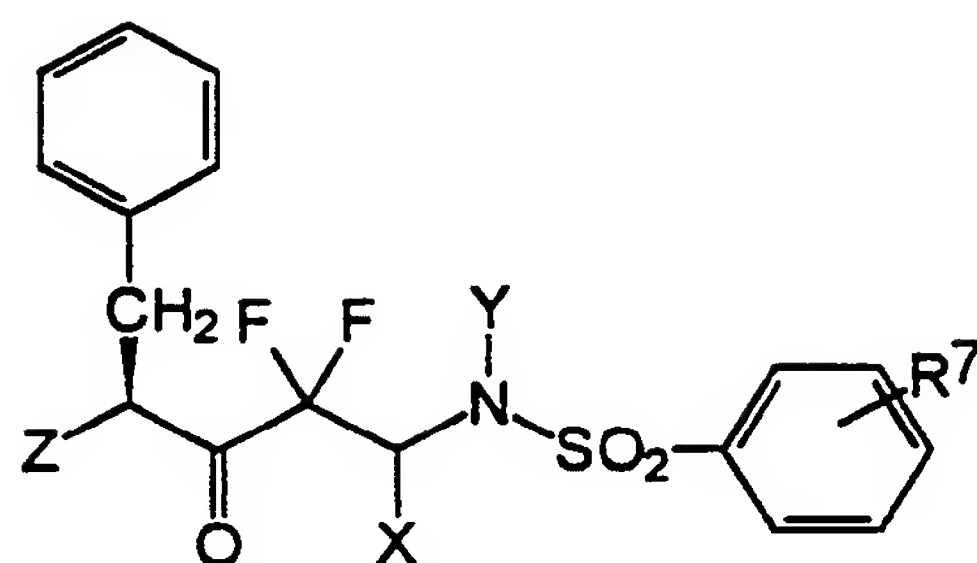
1084	 <chem>CC(=O)c1ccccc1NCCc2ccccc2</chem>	 <chem>CCCC1CCCC1</chem>	 <chem>CC1=C(C)SC(=N1)C(=O)N</chem>
1085	 <chem>CC(=O)c1ccccc1NCCc2ccccc2</chem>	 <chem>CCCC1CCCC1</chem>	 <chem>CC1=CSC=N1</chem>

TABLE 3



COMPOUND	Z	X	Y	R <sup>7</sup>
XXXIV			H	4-NH <sub>2</sub>
LXVIII			H	4-OCH <sub>3</sub>
XXXV		H		4-NH <sub>2</sub>

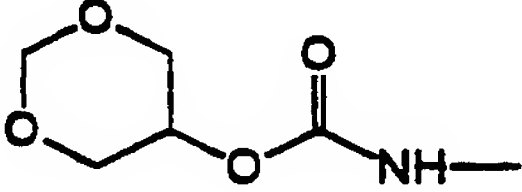

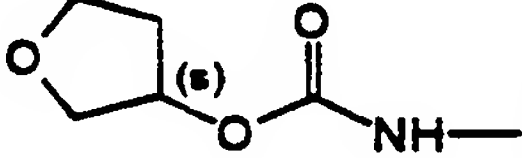
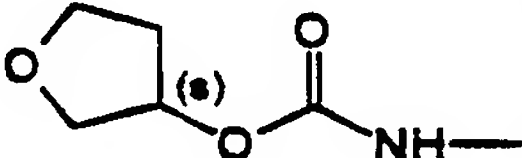
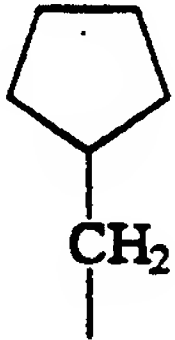
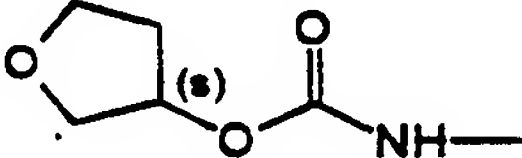
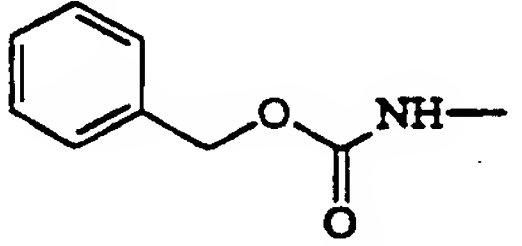

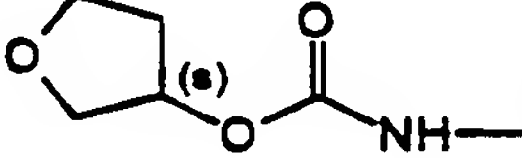
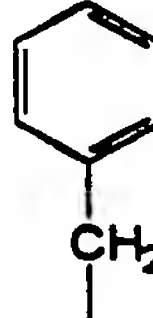
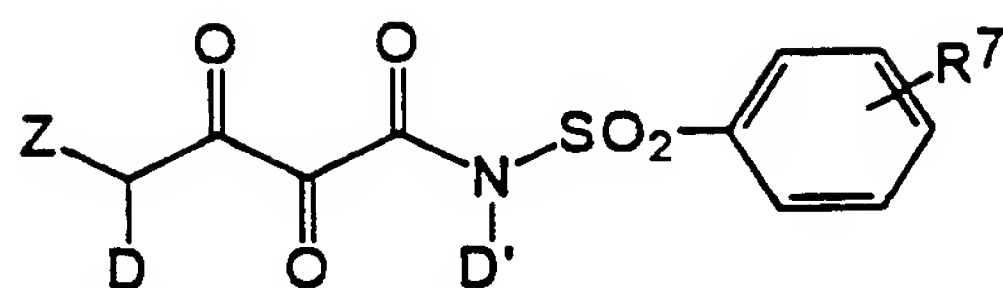
LXIX		H		4-OCH <sub>3</sub>
La		H	i-Bu	4-OCH <sub>3</sub>
Lb		H		4-OCH <sub>3</sub>
Lc		i-Bu	H	4-OCH <sub>3</sub>
Ld		H		4-OCH <sub>3</sub>
Lf		H		4-OCH <sub>3</sub>

TABLE 4



COMPOUND	Z	D	D'	R <sup>7</sup>
XL				4-OCH <sub>3</sub>
LXX				4-OCH <sub>3</sub>
LXXI				4-OCH <sub>3</sub>
LIV			i-Bu	4-OCH <sub>3</sub>

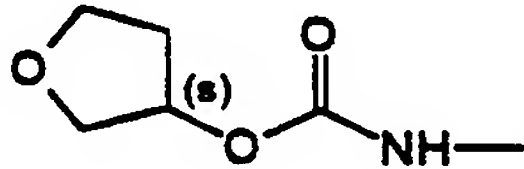
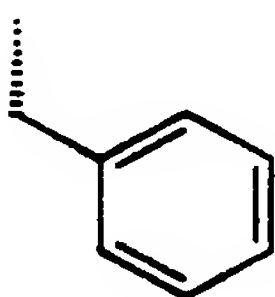
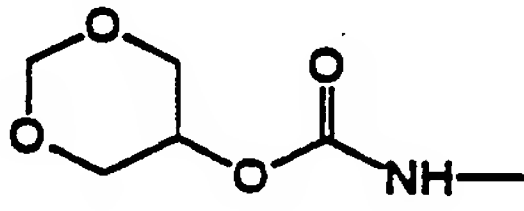
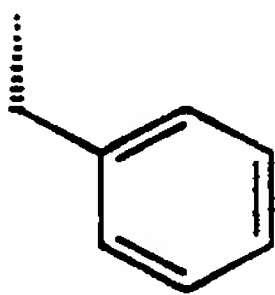
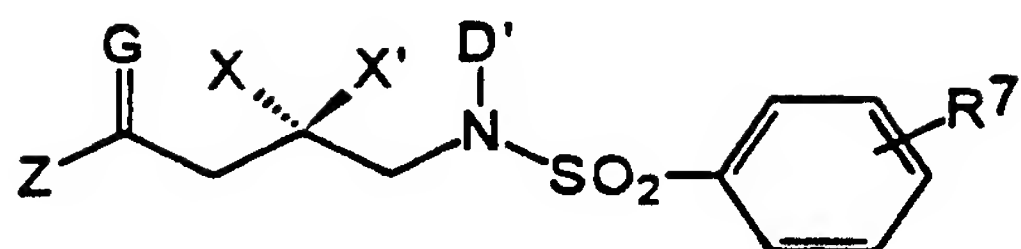
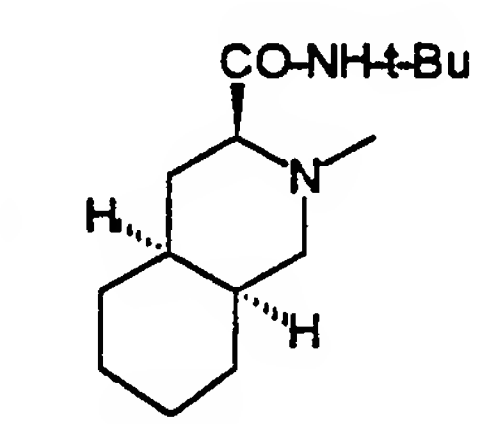
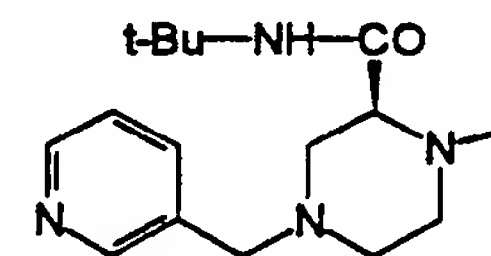
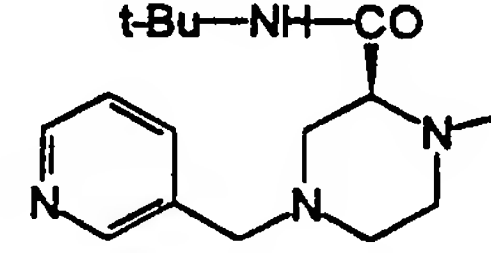
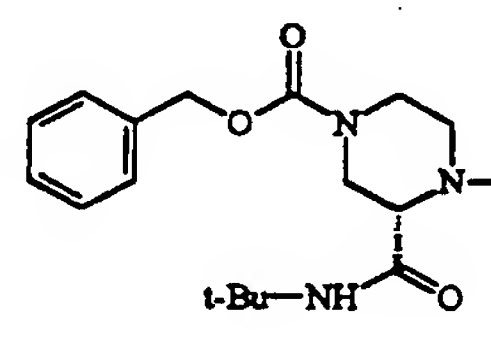
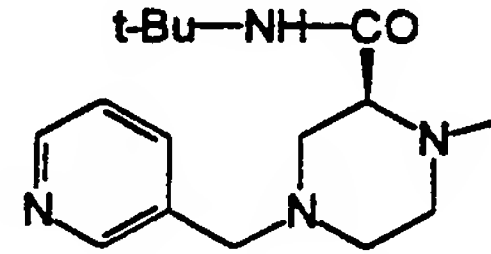
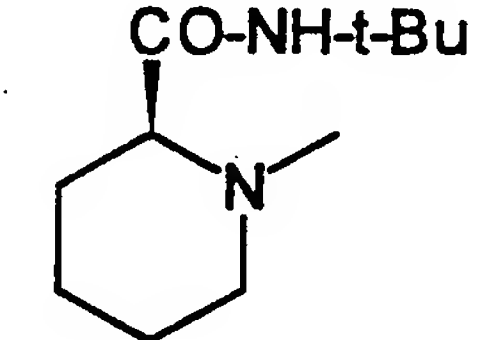
LXXII			i-Bu	4-OCH <sub>3</sub>
LXXIII			i-Bu	4-OCH <sub>3</sub>

TABLE 5



COMPOUND	Z	G	X	X'	D'	R <sup>7</sup>
XLI		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>
1030		O	OH	H	i-Bu	4-OCH <sub>3</sub>
LXXXV		H <sub>2</sub>	OH (R,S)	H (R,S)	i-Bu	4-OCH <sub>3</sub>
XLIII		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>

XLVI		H <sub>2</sub>	OH (R,S)	H (R,S)	i-Bu	4-OCH <sub>3</sub>
XLVII		H <sub>2</sub>	OH (R,S)	H (R,S)	i-Bu	4-OCH <sub>3</sub>
LXXXIII		O	OH (R,S)	H (R,S)	i-Bu	4-OCH <sub>3</sub>
1031		O	OH	H	i-Bu	4-OCH <sub>3</sub>
1032		O	OH	H	i-Bu	4-OCH <sub>3</sub>
1033		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>

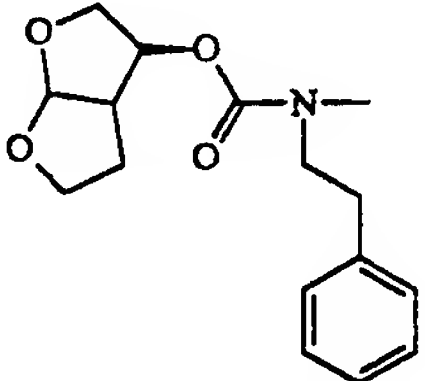
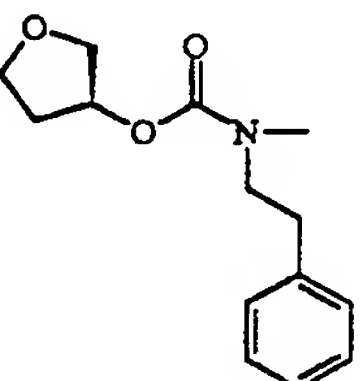
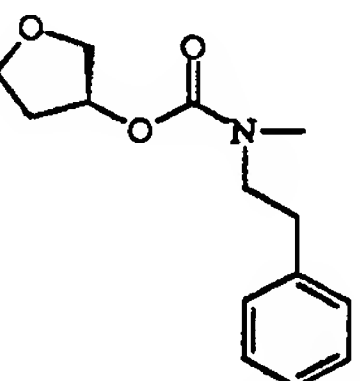
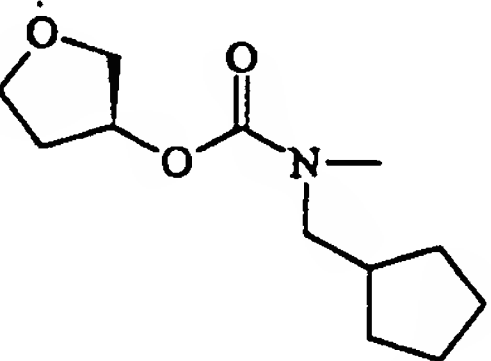
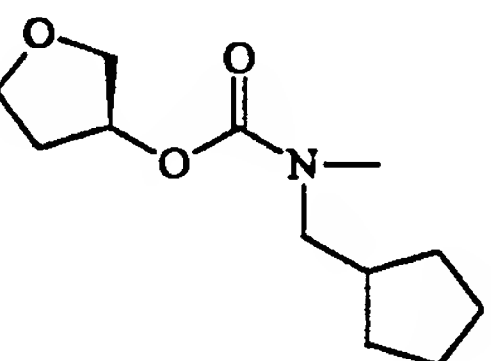
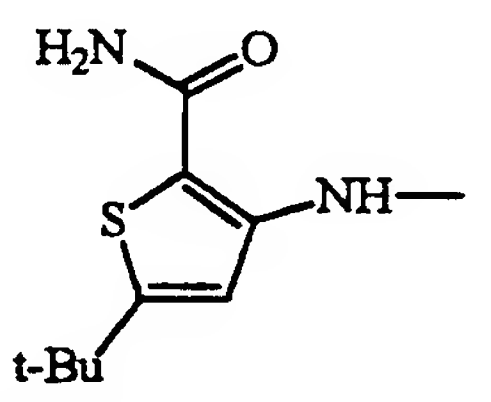
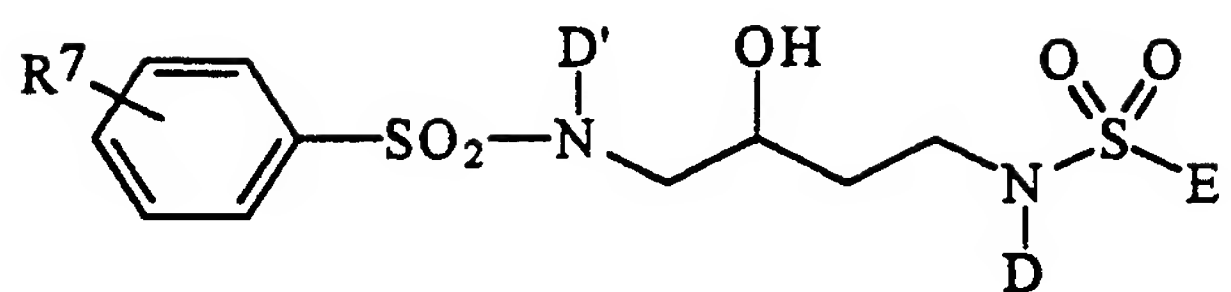
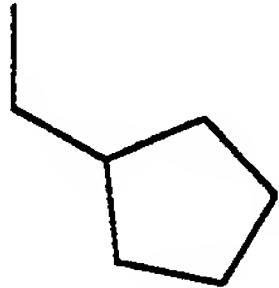
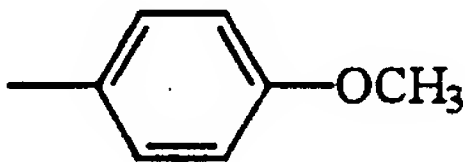
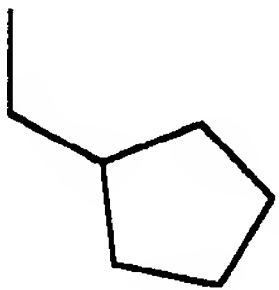
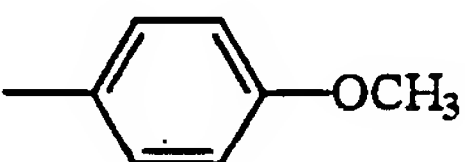
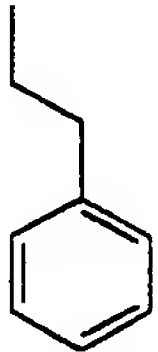
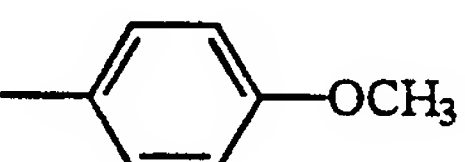
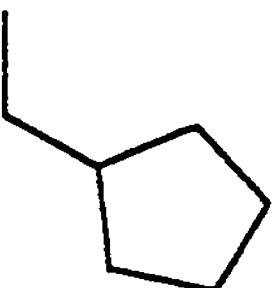
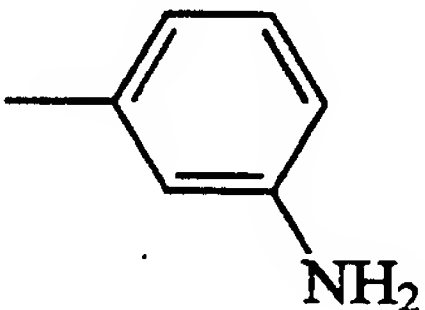
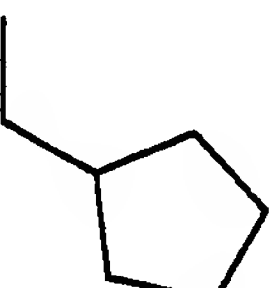
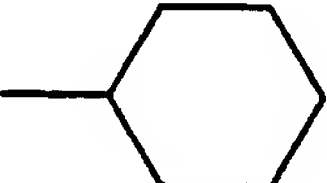
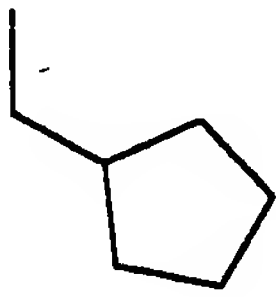
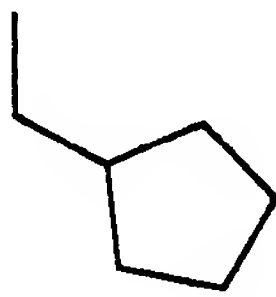
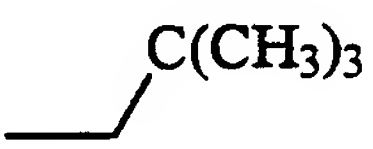
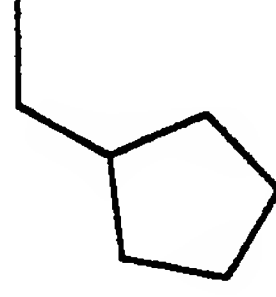
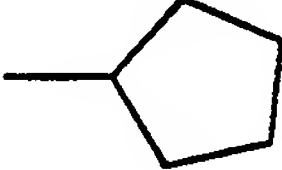
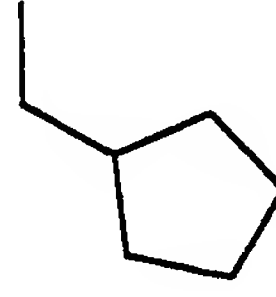
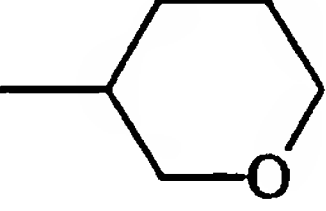
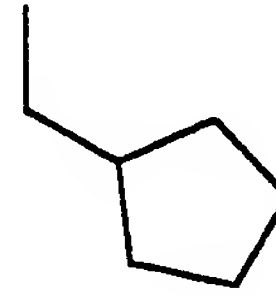
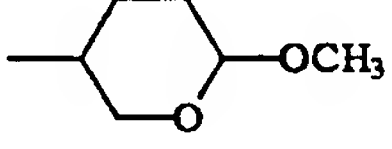
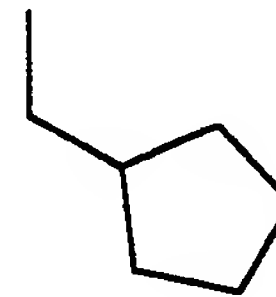
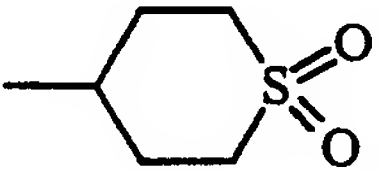
1036		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>
1037		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>
1038		H <sub>2</sub>	H	OH	i-Bu	4-OCH <sub>3</sub>
1039		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>
1040		H <sub>2</sub>	H	OH	i-Bu	4-OCH <sub>3</sub>
1042		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>

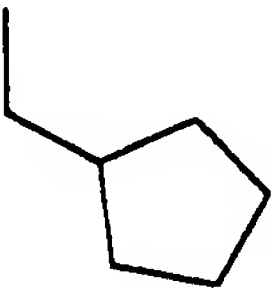
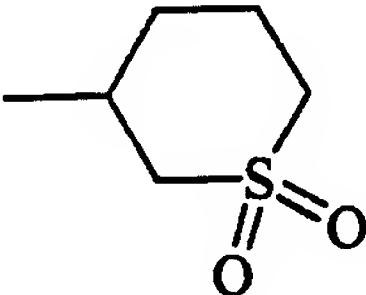
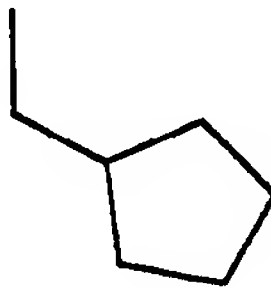
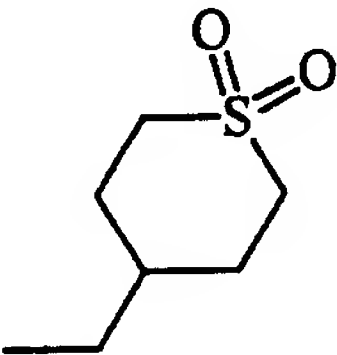
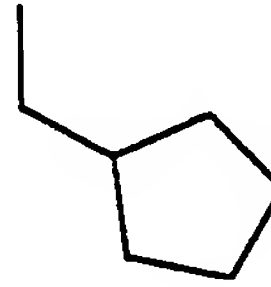
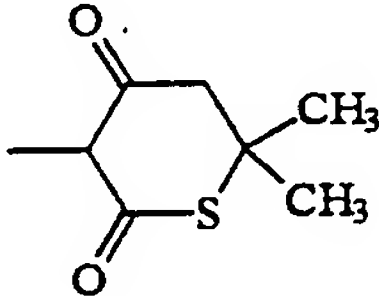
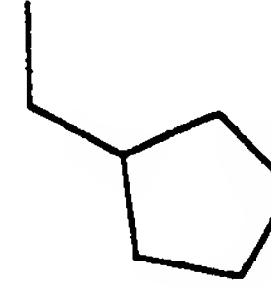
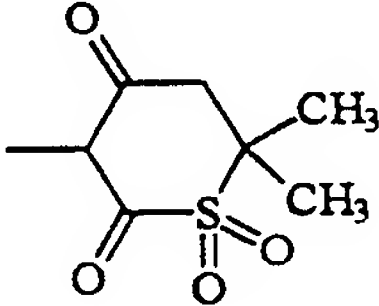
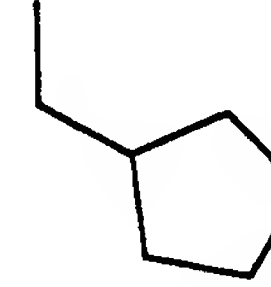
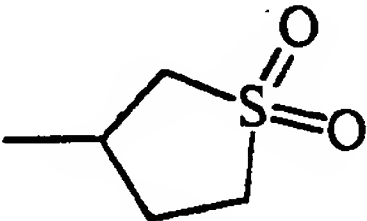
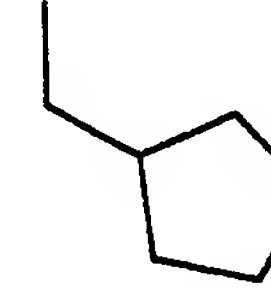
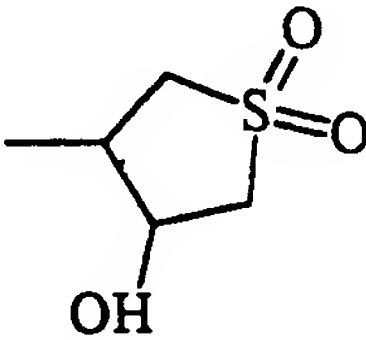
TABLE 6

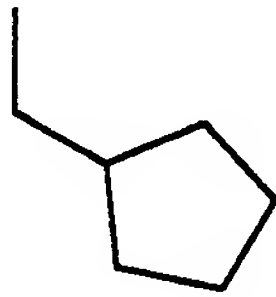
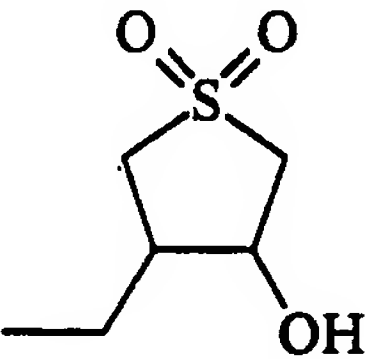
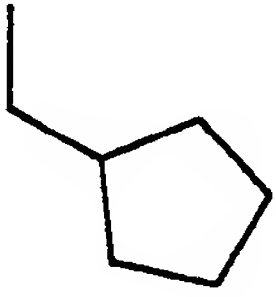
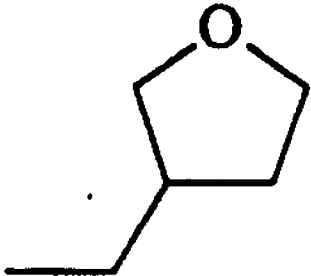
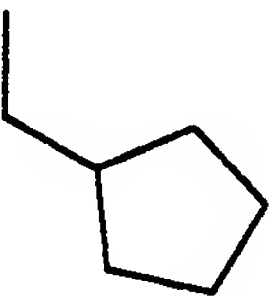
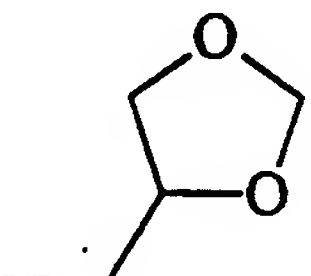
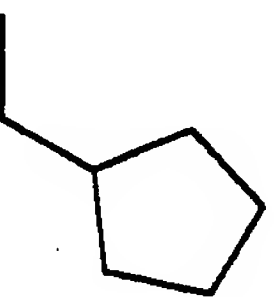
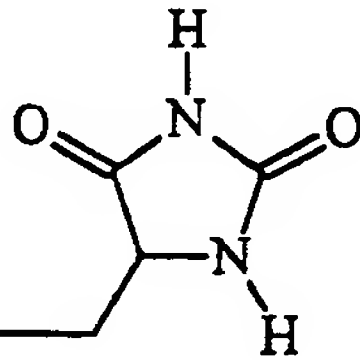
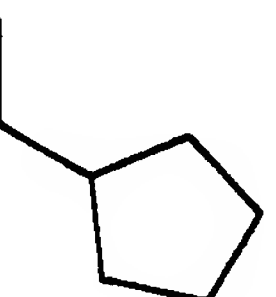
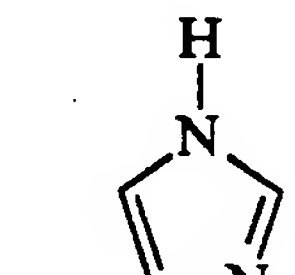
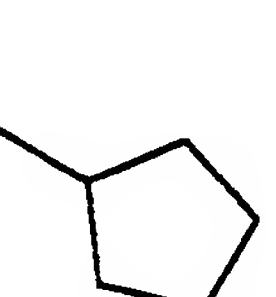
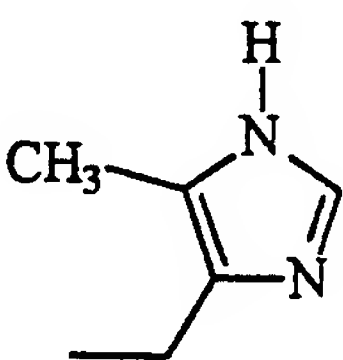


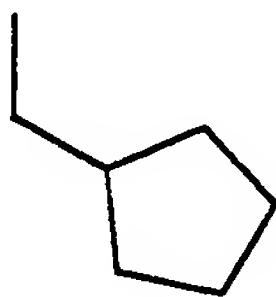
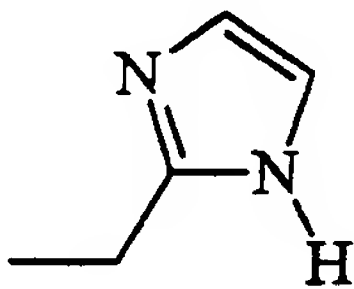
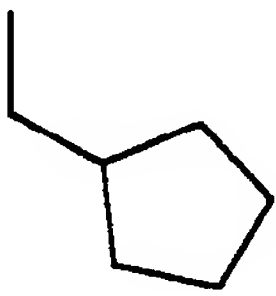
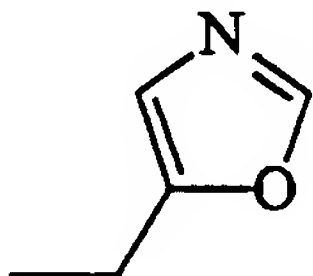
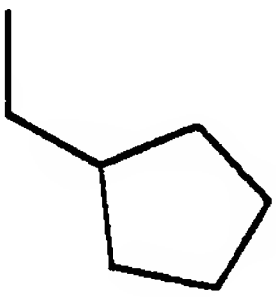
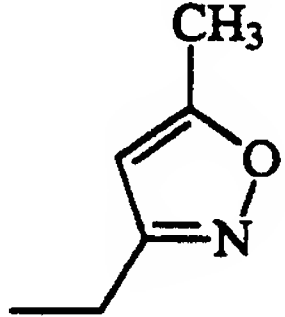
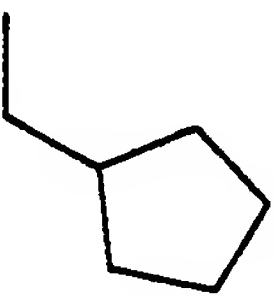
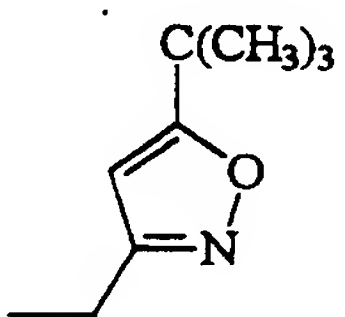
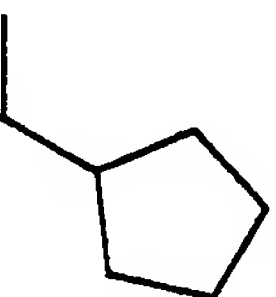
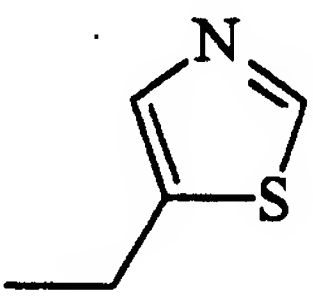
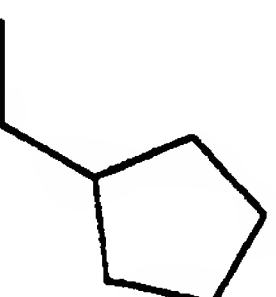
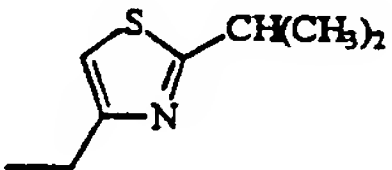
COMPOUND	OH	R <sup>7</sup>	D'	D	E
XLIVa	S	4-OCH <sub>3</sub>	i-Bu	i-Bu	
XLIVb	R	4-OCH <sub>3</sub>	i-Bu	i-Bu	
XLV	S	4-OH	i-Bu		
XLIX	S	4-NH <sub>2</sub>			

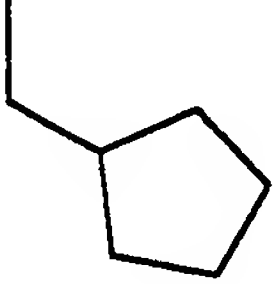
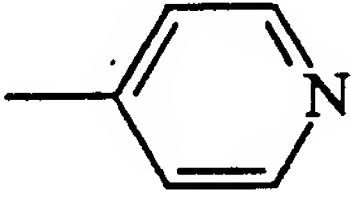
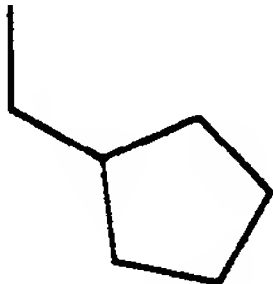
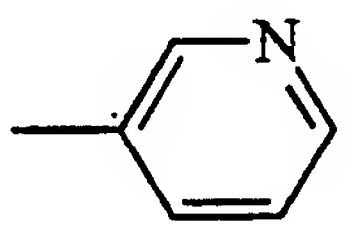
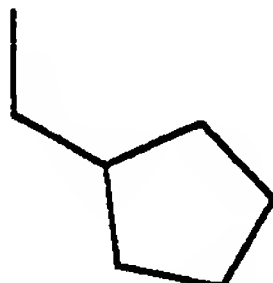
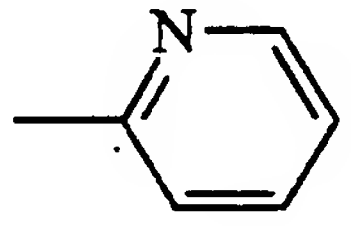
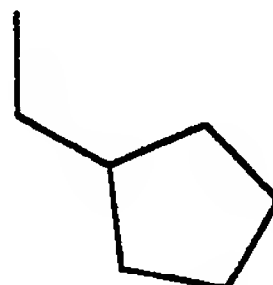
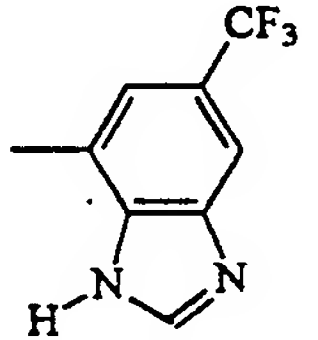
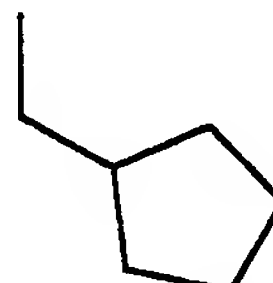
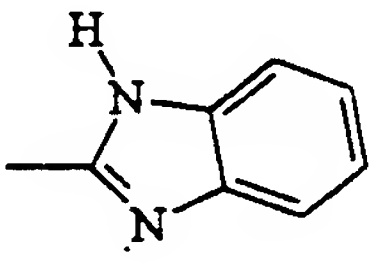
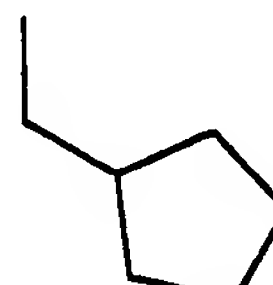
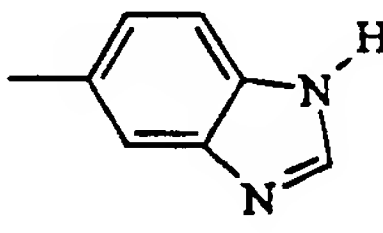
LVa	S	4-OCH <sub>3</sub>	i-Bu		
LVb	R	4-OCH <sub>3</sub>	i-Bu		
1034	S	4-OCH <sub>3</sub>	i-Bu	i-Bu	—N(CH <sub>3</sub> ) <sub>2</sub>
1035	S	4-OCH <sub>3</sub>	i-Bu		
1041	S	4-OCH <sub>3</sub>	i-Bu		
1086	S	4-OCH <sub>3</sub>	i-Bu		

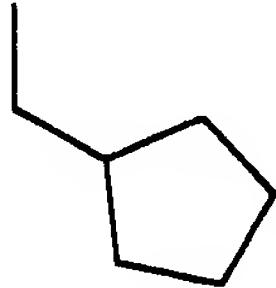
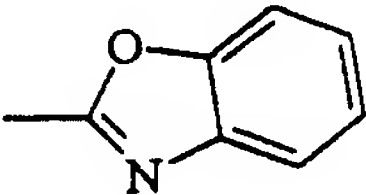
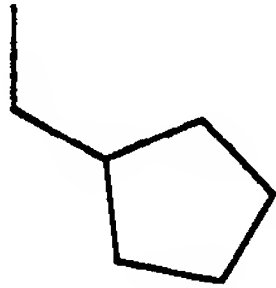
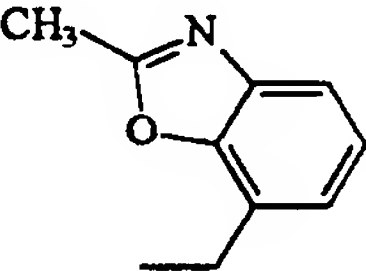
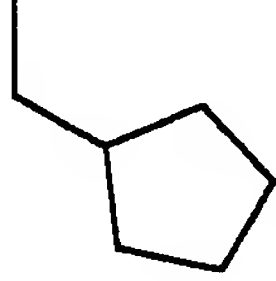
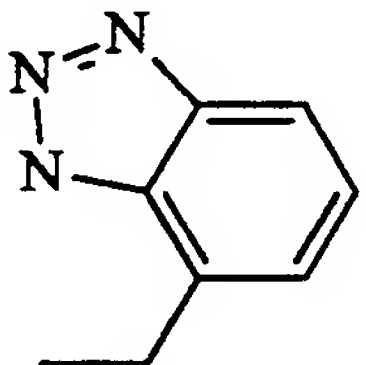
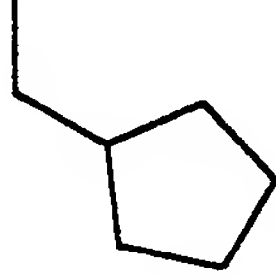
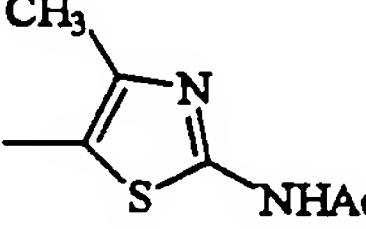
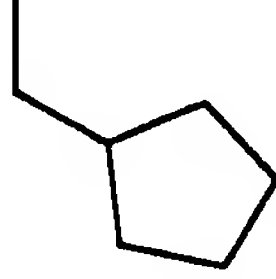
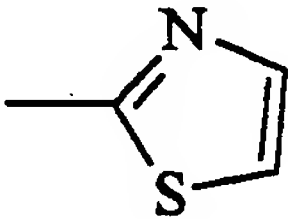
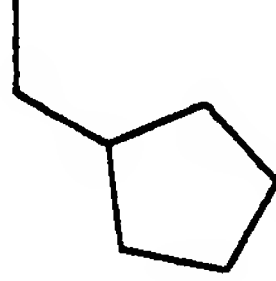
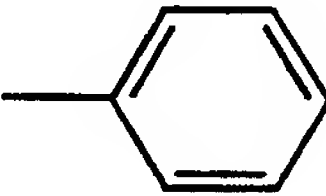
1087	S	4-OCH <sub>3</sub>	i-Bu		t-Bu
1088	S	4-OCH <sub>3</sub>	i-Bu		
1089	S	4-OCH <sub>3</sub>	i-Bu		
1090	S	4-OCH <sub>3</sub>	i-Bu		
1091	S	4-OCH <sub>3</sub>	i-Bu		
1092	S	4-OCH <sub>3</sub>	i-Bu		

1093	S	4-OCH <sub>3</sub>	i-Bu		
1094	S	4-OCH <sub>3</sub>	i-Bu		
1095	S	4-OCH <sub>3</sub>	i-Bu		
1096	S	4-OCH <sub>3</sub>	i-Bu		
1097	S	4-OCH <sub>3</sub>	i-Bu		
1098	S	4-OCH <sub>3</sub>	i-Bu		

1099	S	4-OCH <sub>3</sub>	i-Bu		
1100	S	4-OCH <sub>3</sub>	i-Bu		
1101	S	4-OCH <sub>3</sub>	i-Bu		
1102	S	4-OCH <sub>3</sub>	i-Bu		
1103	S	4-OCH <sub>3</sub>	i-Bu		
1104	S	4-OCH <sub>3</sub>	i-Bu		

1105	S	4-OCH <sub>3</sub>	i-Bu		
1106	S	4-OCH <sub>3</sub>	i-Bu		
1107	S	4-OCH <sub>3</sub>	i-Bu		
1108	S	4-OCH <sub>3</sub>	i-Bu		
1109	S	4-OCH <sub>3</sub>	i-Bu		
1110	S	4-OCH <sub>3</sub>	i-Bu		

1111	S	4-OCH <sub>3</sub>	i-Bu		
1112	S	4-OCH <sub>3</sub>	i-Bu		
1113	S	4-OCH <sub>3</sub>	i-Bu		
1114	S	4-OCH <sub>3</sub>	i-Bu		
1115	S	4-OCH <sub>3</sub>	i-Bu		
1116	S	4-OCH <sub>3</sub>	i-Bu		

1117	S	4-OCH <sub>3</sub>	i-Bu		
1118	S	4-OCH <sub>3</sub>	i-Bu		
1119	S	4-OCH <sub>3</sub>	i-Bu		
1120	S	4-OCH <sub>3</sub>	i-Bu		
1121	S	4-OCH <sub>3</sub>	i-Bu		
1122	S	4-OCH <sub>3</sub>	i-Bu		

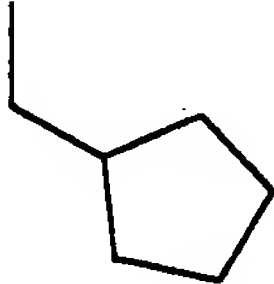
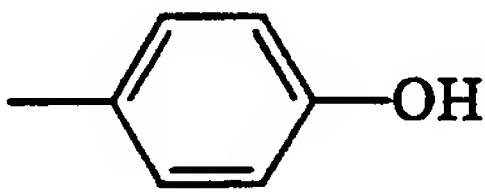
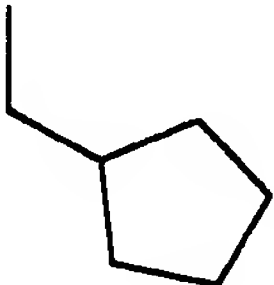
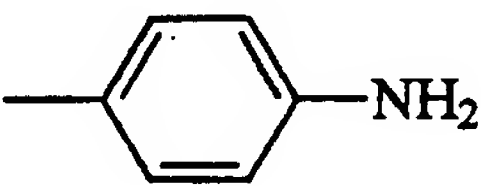
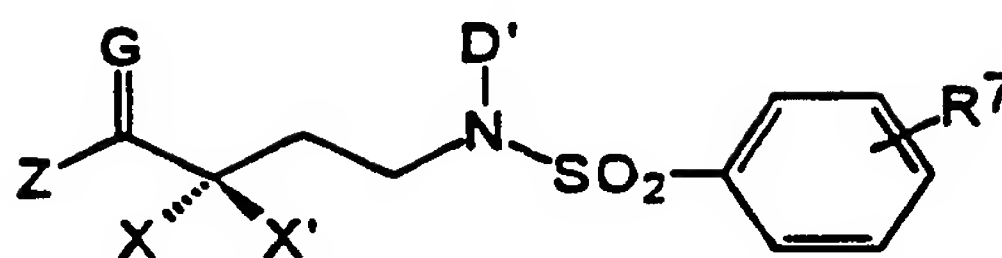
1123	S	4-OCH <sub>3</sub>	i-Bu		
1124	S	4-OCH <sub>3</sub>	i-Bu		

TABLE 7



COMPOUND	Z	G	X	X'	D'	R <sup>7</sup>
XLVIII		H <sub>2</sub>	H	OH	i-Bu	4-OCH <sub>3</sub>
LXXIV		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>
LXXV		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>

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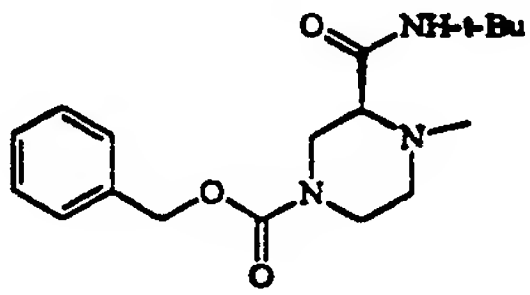
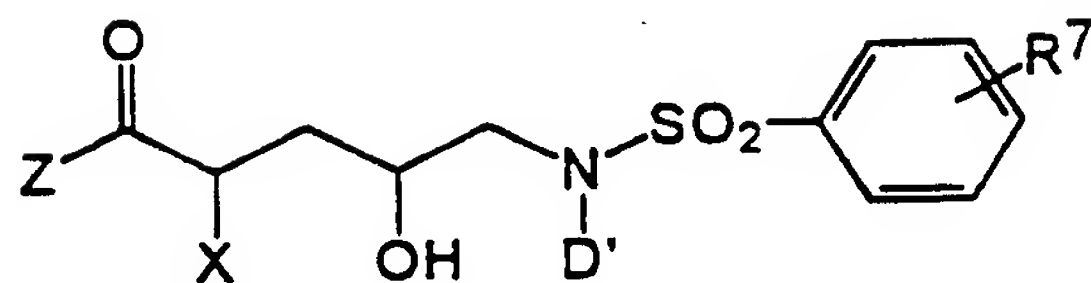
LXXVI		H <sub>2</sub>	OH	H	i-Bu	4-OCH <sub>3</sub>
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TABLE 8



COMPOUND	OH	Z	X	D'	R <sup>7</sup>
LI	S	i-Bu-NH		i-Bu	4-OCH <sub>3</sub>
LII	S			i-Bu	4-OCH <sub>3</sub>
LIII	S			i-Bu	4-OCH <sub>3</sub>

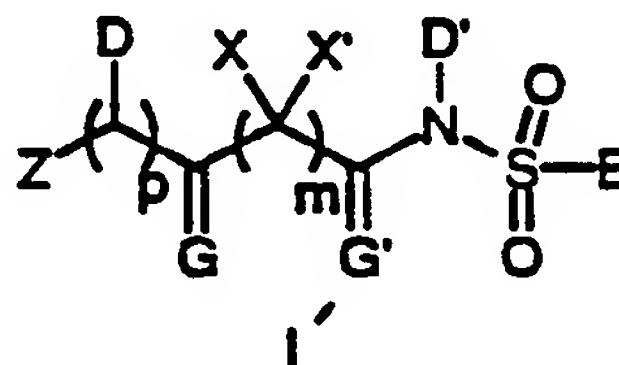
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More preferred sulfonamides of this invention include the following compounds: XLIVa, XLV, LII, LVa, 1000, 1001, 1005, 1007, 1008, 1009, 1010, 1011, 1012, 1013, 1014, 1015, 1016, 1017, 1018, 1019, 1020, 1021, 1022, 1023, 1024, 1025, 1026, 1027, 1045, and 1041.

The most preferred sulfonamides of this invention are compounds XLIVa, XLV, LII, LVa, 1001, 1005, 1007, 1008, 1009, 1010, 1011, 1013, 1015, 1016, 1018, 1019, 1021, 1023, 1024, 1026, 1027, 1045, and 1041.

In an alternative embodiment, the sulfonamides of this invention are those of formulas I', II' and III':

Formula I':



wherein:

each D and D' is independently selected from the group consisting of Ar; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-Ar and Ar; C<sub>2</sub>-C<sub>4</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-Ar and Ar; C<sub>3</sub>-C<sub>6</sub> cycloalkyl, which may be optionally substituted with or fused with Ar; and C<sub>5</sub>-C<sub>6</sub> cycloalkenyl, which may be optionally substituted with or fused with Ar;

each Ar is independently selected from the group consisting of phenyl; 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting

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of O, N, S,  $S(O)_n$  and  $N(R^2)$ , wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of oxo,  $-OR^2$ ,  $-R^2$ ,  $-N(R^2)(R^2)$ ,  
 5  $-N(R^2)-C(O)-R^2$ ,  $-R^2-OH$ ,  $-CN$ ,  $-CO_2R^2$ ,  $-C(O)-N(R^2)(R^2)$ , halo and  $-CF_3$ ;

each  $R^2$  is independently selected from the group consisting of H and  $C_1-C_4$  alkyl optionally substituted with phenyl, 3-6 membered carbocyclic ring  
 10 and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S and  $S(O)_n$ , wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected  
 15 from the group consisting of OH,  $NH_2$ , CN,  $C_1-C_4$  alkyl,  $C_1-C_4$  alkoxy, halogen and  $CF_3$ ;

each  $R^3$  is independently selected from the group consisting of H, Het,  $C_1-C_6$  alkyl,  $C_2-C_6$  alkenyl,  $C_3-C_6$  cycloalkyl and  $C_5-C_6$  cycloalkenyl, wherein any  
 20 member of said  $R^3$ , except H, may be optionally substituted with one or more substituents selected from the group consisting of  $-OR^2$ ,  $-C(O)-NH-R^2$ ,  $-S(O)_n-$ ,  $N(R^2)(R^2)$ , Het,  $-CN$ ,  $-SR^2$ ,  $-CO_2R^2$  and  $NR^2-C(O)-R^2$ ;

each Het is independently selected from the group consisting of  $C_3-C_7$  cycloalkyl;  $C_5-C_7$  cycloalkenyl;  $C_6-C_{10}$  aryl; and 5-10 membered saturated or unsaturated heterocycle, containing one or more heteroatoms  
 25 selected from the group consisting of N,  $N(R^2)$ , O, S and  $S(O)_n$ , wherein said heterocycle may optionally be benzofused; wherein said heterocycle may be bicyclic or monocyclic; and wherein any member of said Het may be optionally substituted with one or more substituents  
 30 selected from the group consisting of oxo,  $-OR^2$ ,  $-R^2$ ,  $-N(R^2)(R^2)$ ,  $-R^2-OH$ ,  $-CN$ ,  $-CO_2R^2$ ,  $-C(O)-N(R^2)(R^2)$ ,  $-S(O)_2-$ ,  $N(R^2)(R^2)$ ,  $-N(R^2)-C(O)-R^2$ ,  $-C(O)-R^2$ ,  $-S(O)_n-R^2$ ,  $-OCF_3$ , -  
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$S(O)_n$ -Ar, methylenedioxy,  $-N(R^2)-S(O)_2(R^2)$ , halo,  $-CF_3$ ,  $-NO_2$ , Ar,  $-O$ -Ar,  $-C(O)-N(D)(D)$ ,  $-C(O)-N(H)D$ , and  $-S(O)_n$ -D;

5 each E is independently selected from the group consisting of Het; O-Het; Het-Het;  $-O-R^3$ ;  $-NR^2R^3$ ;  $C_1$ - $C_6$  alkyl, which may be optionally substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_2$ - $C_6$  alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_3$ - $C_6$  saturated monocyclic carbocycle, which be optionally benzofused, and which may optionally be substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_5$ - $C_6$  unsaturated carbocycle, which may optionally be substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_8$ - $C_{10}$  saturated bicyclic carbocycle, which may be optionally substituted with one or more groups selected from the group consisting of  $R^4$  and Het;

20 each  $R^4$  is independently selected from the group consisting of  $-OR^2$ ,  $-C(O)-NHR^2$ ,  $-S(O)_2-NHR^2$ , halo,  $-NR^2-C(O)-R^2$ ,  $-CN$ ,  $-N(R^2)(R^2)$ ,  $-NO_2$ ,  $-C(O)N(D)(D)$  and  $-C(O)N(H)D$ ;

25 each n is independently 1 or 2;  
m is an integer selected from 1, 2 and 3;  
p is an integer selected from 0 and 1;  
G and G' are independently selected from the group consisting of  $H_2$  and O;

30 each X and X' is independently selected from the group consisting of hydrogen;  $-OH$ ;  $-NH_2$ ;  $-SH$ ; D; halogen and, if X and X' are taken together, oxygen;

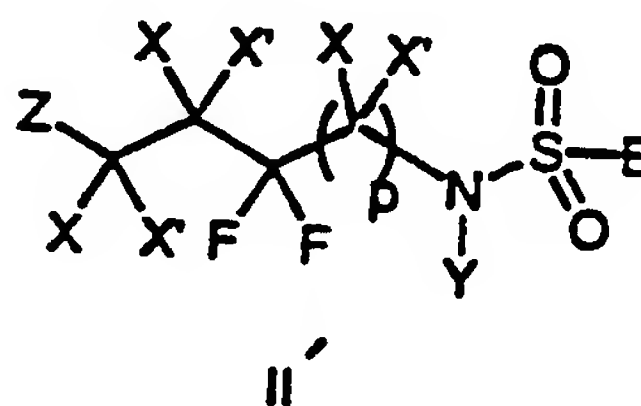
Z is selected from the group consisting of  $-N(D)SO_2E$ ;  $-N(D)SO_2Het$ ;  $-N(H)A$ ;  $-N(D)A$ ;  $-N(H)E$ ;  $-N(H)C(O)N(D)(E)$ ;  $-N(H)-Het$ ;  $-Het$  and  $-N(D)-Het$ ;

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each A is independently selected from the group consisting of H; Het;  $-R^1$ -Het;  $-R^1-C_1-C_6$  alkyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy,  $C_1-C_4$  alkoxy, Het,  $-O$ -Het,  $-NR^2-CO-N(R^2)(R^2)$  and  $-CO-N(R^2)(R^2)$ ; and  $-R^1-C_2-C_6$  alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy,  $C_1-C_4$  alkoxy, Het,  $-O$ -Het,  $-NR^2-CO-N(R^2)(R^2)$  and  $-CO-N(R^2)(R^2)$ ; and

each  $R^1$  is independently selected from the group consisting of  $-C(O)-$ ,  $-S(O)_2-$ ,  $-C(O)-C(O)-$ ,  $-O-C(O)-$ ,  $-O-S(O)_2-$ ,  $-NR^2-S(O)_2-$ ,  $-NR^2-C(O)-$  and  $-NR^2-C(O)-C(O)-$ .

Formula II':



wherein:

each E is independently selected from the group consisting of Het;  $O$ -Het; Het-Het;  $-O-R^3$ ;  $-NR^2R^3$ ;  $C_1-C_6$  alkyl, which may be optionally substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_2-C_6$  alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_3-C_6$  saturated monocyclic carbocycle, which be optionally benzofused, and which may optionally be substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_5-C_6$  unsaturated carbocycle, which may optionally be substituted with one or more groups selected from

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the group consisting of  $R^4$  and Het;  $C_8-C_{10}$  saturated bicyclic carbocycle, which may be optionally substituted with one or more groups selected from the group consisting of  $R^4$  and Het;

5           each  $R^4$  is independently selected from the group consisting of  $-OR^2$ ,  $-C(O)-NHR^2$ ,  $-S(O)_2-NHR^2$ , halo,  $-NR^2-C(O)-R^2$ ,  $-CN$ ,  $-C(O)N(D)(D)$  and  $-C(O)N(H)D$ ;

          each  $n$  is independently 1 or 2;

$p$  is an integer selected from 0 and 1;

10           each  $Y$  is independently selected from the group consisting of hydrogen and  $D$ ;

          each  $D$  is independently selected from the group consisting of Ar;  $C_1-C_6$  alkyl, which may be optionally substituted with one or more groups selected from the group consisting of  $C_3-C_6$  cycloalkyl,  $-OR^2$ ,  $-R^3$ ,  $-O-Ar$  and Ar;  $C_2-C_4$  alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of  $C_3-C_6$  cycloalkyl,  $-OR^2$ ,  $-R^3$ ,  $-O-Ar$  and Ar;  $C_3-C_6$  cycloalkyl, which may be optionally substituted with or fused with Ar; and  $C_5-C_6$  cycloalkenyl, which may be optionally substituted with or fused with Ar;

          each Ar is independently selected from the group consisting of phenyl; 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S,  $S(O)_n$  and  $N(R^2)$ , wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of oxo,  $-OR^2$ ,  $-R^2$ ,  $-N(R^2)(R^2)$ ,  $-N(R^2)-C(O)-R^2$ ,  $-R^2-OH$ ,  $-CN$ ,  $-CO_2R^2$ ,  $-C(O)-N(R^2)(R^2)$ , halo and  $-CF_3$ ;

          each  $R^2$  is independently selected from the group consisting of H and  $C_1-C_4$  alkyl optionally substituted with phenyl, 3-6 membered carbocyclic ring

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and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S and  $S(O)_n$ , wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of OH,  $NH_2$ , CN,  $C_1-C_4$  alkyl,  $C_1-C_4$  alkoxy, halogen and  $CF_3$ ;

each  $R^3$  is independently selected from the group consisting of H, Het,  $C_1-C_6$  alkyl,  $C_2-C_6$  alkenyl,  $C_3-C_6$  cycloalkyl and  $C_5-C_6$  cycloalkenyl, wherein any member of said  $R^3$ , except H, may be optionally substituted with one or more substituents selected from the group consisting of  $-OR^2$ ,  $-C(O)-NH-R^2$ ,  $-S(O)_n-N(R^2)(R^2)$ , Het,  $-CN$ ,  $-SR^2$ ,  $-CO_2R^2$  and  $NR^2-C(O)-R^2$ ;

each Het is independently selected from the group consisting of  $C_3-C_7$  cycloalkyl;  $C_5-C_7$  cycloalkenyl;  $C_6-C_{10}$  aryl; and 5-10 membered saturated or unsaturated heterocycle, containing one or more heteroatoms selected from the group consisting of N,  $N(R^2)$ , O, S and  $S(O)_n$ , wherein said heterocycle may optionally be benzofused; wherein said heterocycle may be bicyclic or monocyclic; and wherein any member of said Het may be optionally substituted with one or more substituents selected from the group consisting of oxo,  $-OR^2$ ,  $-R^2$ ,  $-N(R^2)(R^2)$ ,  $-R^2-OH$ ,  $-CN$ ,  $-CO_2R^2$ ,  $-C(O)-N(R^2)(R^2)$ ,  $-S(O)_2-N(R^2)(R^2)$ ,  $-N(R^2)-C(O)-R^2$ ,  $-C(O)-R^2$ ,  $-S(O)_n-R^2$ ,  $-OCF_3$ ,  $-S(O)_n-Ar$ , methylenedioxy,  $-N(R^2)-S(O)_2(R^2)$ , halo,  $-CF_3$ ,  $-NO_2$ , Ar,  $-O-Ar$ ,  $-C(O)-N(D)(D)$ ,  $-C(O)N(H)D$ , and  $-S(O)_n-D$ ;

each Z is independently selected from the group consisting of  $-N(D)SO_2E$ ;  $-N(D)SO_2Het$ ;  $-N(H)A$ ;  $-N(D)A$ ;  $-N(H)E$ ;  $-N(H)C(O)N(D)(E)$ ;  $-N(H)-Het$ ;  $-Het$  and  $-N(D)-Het$ ;

each A is independently selected from the group consisting of H; Het;  $-R^1-Het$ ;  $-R^1-C_1-C_6$  alkyl, which may be optionally substituted with one or more

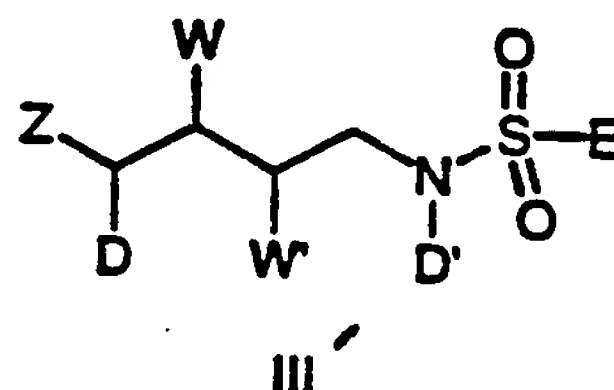
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groups selected from the group consisting of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het and -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>) and -CO-N(R<sup>2</sup>)(R<sup>2</sup>); and -R<sup>1</sup>-C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>) and -CO-N(R<sup>2</sup>)(R<sup>2</sup>);

each R<sup>1</sup> is independently selected from the group consisting of -C(O)-, -S(O)<sub>2</sub>-, -C(O)-C(O)-, -O-C(O)-, -O-S(O)<sub>2</sub>-, -NR<sup>2</sup>-S(O)<sub>2</sub>-, -NR<sup>2</sup>-C(O)- and -NR<sup>2</sup>-C(O)-C(O)-; and

each X and X' is independently selected from the group consisting of hydrogen; -OH; -NH<sub>2</sub>; -SH; D and, if X and X' are taken together, oxygen.

Formula III':



wherein:

each D and D' is independently selected from the group consisting of Ar; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-Ar and Ar; C<sub>2</sub>-C<sub>4</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-Ar and Ar; C<sub>3</sub>-C<sub>6</sub> cycloalkyl, which may be optionally substituted with or fused with Ar; and C<sub>5</sub>-C<sub>6</sub>

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cycloalkenyl, which may be optionally substituted with or fused with Ar;

each Ar is independently selected from the group consisting of phenyl; 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S,  $S(O)_n$  and  $N(R^2)$ , wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of oxo,  $-OR^2$ ,  $-R^2$ ,  $-N(R^2)(R^2)$ ,  $-N(R^2)-C(O)-R^2$ ,  $-R^2-OH$ ,  $-CN$ ,  $-CO_2R^2$ ,  $-C(O)-N(R^2)(R^2)$ , halo and  $-CF_3$ ;

each  $R^2$  is independently selected from the group consisting of H and  $C_1-C_4$  alkyl optionally substituted with phenyl, 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S and  $S(O)_n$ , wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of OH,  $NH_2$ , CN,  $C_1-C_4$  alkyl,  $C_1-C_4$  alkoxy, halogen and  $CF_3$ ;

each  $R^3$  is independently selected from the group consisting of H, Het,  $C_1-C_6$  alkyl,  $C_2-C_6$  alkenyl,  $C_3-C_6$  cycloalkyl and  $C_5-C_6$  cycloalkenyl, wherein any member of said  $R^3$ , except H, may be optionally substituted with one or more substituents selected from the group consisting of  $-OR^2$ ,  $-C(O)-NH-R^2$ ,  $-S(O)_n-N(R^2)(R^2)$ , Het,  $-CN$ ,  $-SR^2$ ,  $-CO_2R^2$  and  $NR^2-C(O)-R^2$ ;

each Het is independently selected from the group consisting of  $C_3-C_7$  cycloalkyl;  $C_5-C_7$  cycloalkenyl;  $C_6-C_{10}$  aryl; and 5-10 membered saturated or unsaturated heterocycle, containing one or more heteroatoms selected from the group consisting of N,  $N(R^2)$ , O, S and  $S(O)_n$ , wherein said heterocycle may optionally be

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benzofused; wherein said heterocycle may bicyclic or monocyclic; and wherein any member of said Het may be optionally substituted with one or more substituents selected from the group consisting of oxo, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), -S(O)<sub>2</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -C(O)-R<sup>2</sup>, -S(O)<sub>n</sub>-R<sup>2</sup>, -OCF<sub>3</sub>, -S(O)<sub>n</sub>-Ar, methylenedioxy, -N(R<sup>2</sup>)-S(O)<sub>2</sub>(R<sup>2</sup>), halo, -CF<sub>3</sub>, -NO<sub>2</sub>, Ar, -O-Ar, -C(O)-N(D)(D), -C(O)N(H)D, and -S(O)<sub>n</sub>-D;

each E is independently selected from the group consisting of Het; O-Het; Het-Het; -O-R<sup>3</sup>; -NR<sup>2</sup>R<sup>3</sup>; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; C<sub>3</sub>-C<sub>6</sub> saturated monocyclic carbocycle, which be optionally benzofused, and which may optionally be substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; C<sub>5</sub>-C<sub>6</sub> unsaturated carbocycle, which may optionally be substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; C<sub>8</sub>-C<sub>10</sub> saturated bicyclic carbocycle, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; and

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -C(O)-NHR<sup>2</sup>, -S(O)<sub>2</sub>-NHR<sup>2</sup>, halo, -NR<sup>2</sup>-C(O)-R<sup>2</sup>, -CN, -C(O)-N(D)(D) and -C(O)-N(H)D;

each n is independently 1 or 2;

W and W' are independently selected from the group consisting of hydrogen, D and -OH;

each Z is independently selected from the group consisting of -N(D)SO<sub>2</sub>E; -N(D)SO<sub>2</sub>Het; -N(H)A; -N(D)A; -N(H)E; -N(H)C(O)N(D)(E); -N(H)-Het; -Het and -N(D)-Het;

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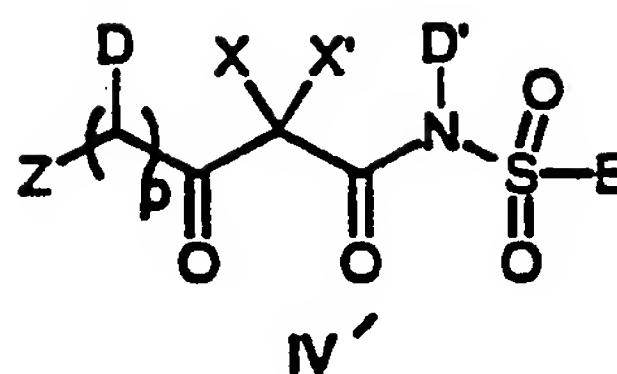
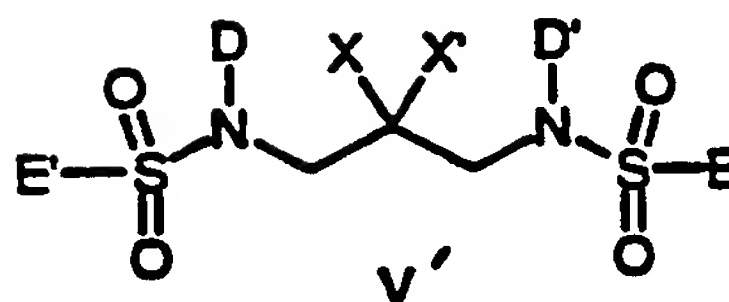
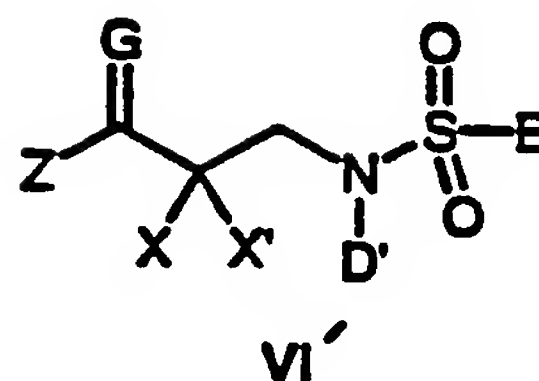
each A is independently selected from the group consisting of H; Het;  $-R^1\text{-Het}$ ;  $-R^1\text{-C}_1\text{-C}_6$  alkyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy,  $\text{C}_1\text{-C}_4$  alkoxy, Het,  $-\text{O-Het}$ ,  $-\text{NR}^2\text{-CO-N(R}^2\text{)(R}^2\text{)}$  and  $-\text{CO-N(R}^2\text{)(R}^2\text{)}$ ; and  $-R^1\text{-C}_2\text{-C}_6$  alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy,  $\text{C}_1\text{-C}_4$  alkoxy, Het,  $-\text{O-Het}$ ,  $-\text{NR}^2\text{-CO-N(R}^2\text{)(R}^2\text{)}$  and  $-\text{CO-N(R}^2\text{)(R}^2\text{)}$ ; and

each  $R^1$  is independently selected from the group consisting of  $-\text{C(O)}-$ ,  $-\text{S(O)}_2-$ ,  $-\text{C(O)-C(O)}-$ ,  $-\text{O-C(O)}-$ ,  $-\text{O-S(O)}_2-$ ,  $-\text{NR}^2\text{-S(O)}_2-$ ,  $-\text{NR}^2\text{-C(O)}-$  and  $-\text{NR}^2\text{-C(O)-C(O)}-$ .

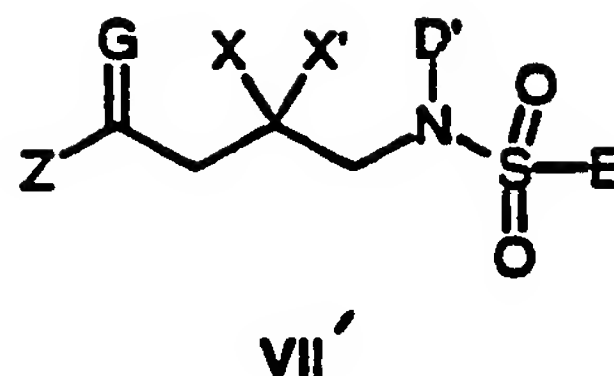
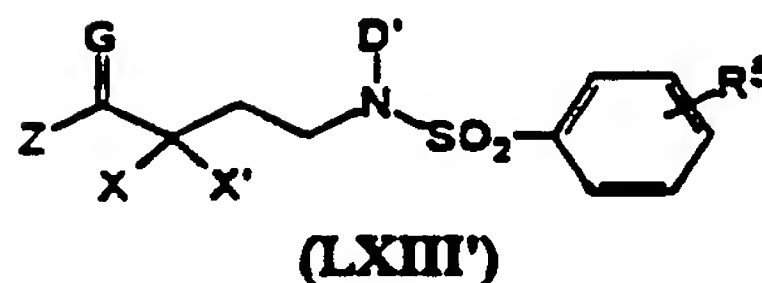
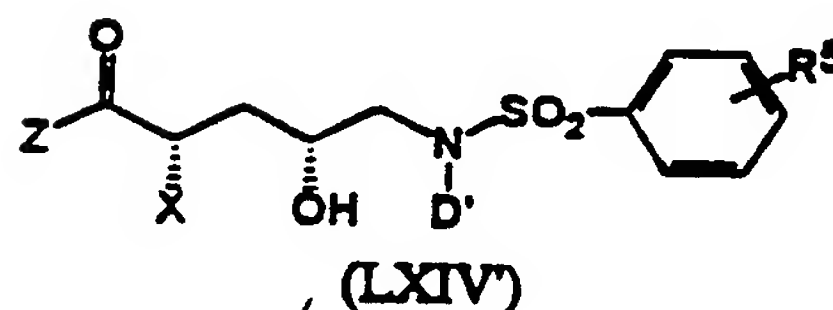
Except where expressly noted to the contrary, the term for any given variable, the term "[variable]" as defined for formulas I', II' or III' refers to the definitions shown directly above.

Preferred compounds of formula I' include those compounds wherein G or G' or both are oxygen. More preferably, when G or G' or both are oxygen (i.e., form a carbonyl with the carbon to which they are attached), the X and X' on the carbon adjacent to the carbonyl are independently selected from the group consisting of H, OH, F, or taken together, oxygen. Preferably, the compounds of formula I' contain from 1 to 4 carbonyls in the backbone of the structures.

Other preferred compounds of formula I' include those compounds having the structures of formulas IV', V', VI', VII', LXIII' and LXIV':

Formula IV':Formula V':Formula VI':

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Formula VII':Formula LXIII':Formula LXIV':

5 wherein D, D', Ar, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, Het, E, R<sup>4</sup>, n, m, p, G, G', X, X', Z and A are as defined for the compounds of formula I' and R<sup>5</sup> is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>. Unless

10 expressly noted to the contrary, the term for any given variable, the term "[variable] as defined for formula IV', V', VI', VII', LXIII' or LXIV'" refers to the definitions shown directly above.

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Preferred compounds of formula IV' include those compounds wherein:

5 each D and D' is independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl and Ar;

10 each Ar is independently selected from the group consisting of phenyl; 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S, S(O)<sub>n</sub> and N(R<sup>2</sup>), wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of oxo, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>),  
15 -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>;

20 each R<sup>2</sup> is independently selected from the group consisting of H and C<sub>1</sub>-C<sub>4</sub> alkyl optionally substituted with phenyl, 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S and S(O)<sub>n</sub>, wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of OH, NH<sub>2</sub>, CN, C<sub>1</sub>-C<sub>4</sub> alkyl,  
25 C<sub>1</sub>-C<sub>4</sub> alkoxy, halogen and CF<sub>3</sub>;

each E is independently selected from C<sub>5</sub>-C<sub>6</sub> unsaturated carbocycle, which may be optionally substituted with one or more R<sup>4</sup>;

30 each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

each Z is independently selected from the group consisting of -N(D)SO<sub>2</sub>E; -N(D)SO<sub>2</sub>Het; -N(H)Het; -N(H)A; -N(D)A and -Het;

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each Het is independently selected from the group consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered saturated or unsaturated heterocycle, containing one or more heteroatoms selected from the group consisting of N, N(R<sup>2</sup>), O, S, and S(O)<sub>n</sub>, wherein said heterocycle may optionally be benzofused; wherein said heterocycle may be bicyclic or monocyclic; and wherein any member of said Het may be optionally substituted with one or more substituents selected from the group consisting of -OR<sup>2</sup>, R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(R<sup>2</sup>)(R<sup>2</sup>) and -S(O)<sub>n</sub>-Ar;

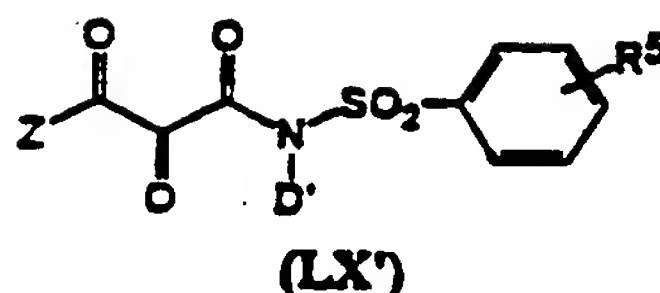
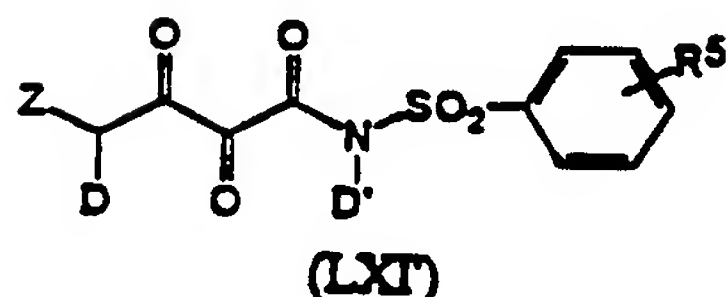
X and X' are independently selected from the group consisting of H, -OH and, most preferably, if X and X' are taken together, oxygen;

each A is independently selected from the group consisting of H; -R<sup>1</sup>-Het and -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl; and

each R<sup>1</sup> is independently selected from the group consisting of -C(O)-, -S(O)<sub>2</sub>-, -C(O)-C(O)-, -O-C(O)-, -O-S(O)<sub>2</sub>-, -NR<sup>2</sup>-S(O)<sub>2</sub>-, -NR<sup>2</sup>-C(O)- and -NR<sup>2</sup>-C(O)-C(O)-.

Other more preferred compounds of formula IV' include those compounds having the structure of formulas LX' and LXI':

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Formula LX':Formula LXI':

wherein D, D', Ar, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, Het, E, R<sup>4</sup>, n, Z and A are defined as above for the compounds of formula IV' and R<sup>5</sup> is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

Preferred compounds of formula V' include those compounds wherein D=D' and E=E' in the backbone of the structure (i.e., a C<sub>2</sub> symmetric structure). Other preferred compounds of formula V' include those compounds wherein X is H and X' is OH in the central carbon of the backbone. Additional preferred compounds of formula V' include those compounds wherein:

- each D and D' is C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl and Ar;
- each X and X' is independently selected from the group consisting of H, -OH and, if X and X' are taken together, oxygen;

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each E and E' is independently selected from C<sub>5</sub>-C<sub>6</sub> unsaturated carbocycle, which may be optionally substituted with one or more R<sup>4</sup>; and

5 each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>.

Preferred compounds of formula VI' include those compounds wherein:

10 each D and D' is independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl and Ar;

X and X' are independently selected from the group consisting of H, if X and X' are taken together, oxygen, and preferably, OH;

15 each E is independently selected from C<sub>5</sub>-C<sub>6</sub> unsaturated carbocycle, which may be optionally substituted with one or more R<sup>4</sup>;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

20 Z is selected from the group consisting of -N(D)SO<sub>2</sub>E; -N(D)SO<sub>2</sub>Het; -N(H)Het; -N(H)A; -N(D)A and -Het;

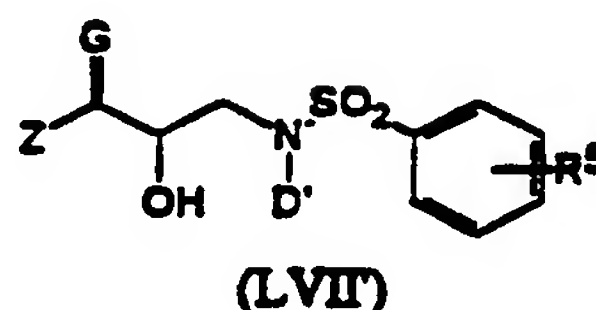
25 each Het is independently selected from the group consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered saturated or unsaturated heterocycle, containing one or more heteroatoms selected from the group consisting of N, N(R<sup>2</sup>), O, S, and S(O)<sub>n</sub>, wherein said heterocycle may optionally be benzofused; wherein said heterocycle may be bicyclic or monocyclic; and wherein any member of  
30 said Het may be optionally substituted with one or more substituents selected from the group consisting of -OR<sup>2</sup>, R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(R<sup>2</sup>)(R<sup>2</sup>) and -S(O)<sub>n</sub>-Ar; and

A is selected from the group consisting of H; -R<sup>1</sup>-Het and -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl.

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Other preferred compounds of formula VI' include those compounds of formula LVII':

Formula LVII':



wherein D, D', Ar, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, Het, E, R<sup>4</sup>, G, n, Z and A are defined as above for the compounds of formula VI' and R<sup>5</sup> is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

Preferred compounds of formula VII' include those compounds wherein:

each D and D' is C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl and Ar;

each X and X' is independently selected from the group consisting of H, if X and X' are taken together, oxygen, and, preferably, OH;

each E is independently selected from C<sub>5</sub>-C<sub>6</sub> unsaturated carbocycle, which may be optionally substituted with one or more R<sup>4</sup>;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

Z is selected from the group consisting of -N(D)SO<sub>2</sub>E; -N(D)SO<sub>2</sub>Het; -N(H)Het; -N(H)A; -N(D)A and -Het;

each Het is independently selected from the group consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered

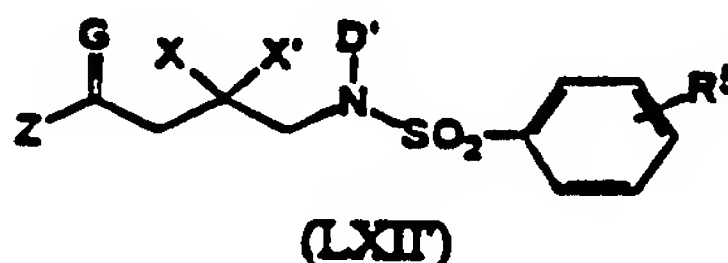
- 83 -

5 saturated or unsaturated heterocycle, containing one or more heteroatoms selected from the group consisting of N, N(R<sup>2</sup>), O, S, and S(O)<sub>n</sub>, wherein said heterocycle may optionally be benzofused; wherein said heterocycle may be bicyclic or monocyclic; and wherein any member of said Het may be optionally substituted with one or more substituents selected from the group consisting of -OR<sup>2</sup>, R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(R<sup>2</sup>)(R<sup>2</sup>) and -S(O)<sub>n</sub>-Ar; and

10 A is selected from the group consisting of H; -R<sup>1</sup>-Het and -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl.

Other preferred compounds of formula VII' are those compounds having the structure of formula LXII':

Formula LXII':



15 wherein D, D', Ar, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, Het, E, R<sup>4</sup>, G, X, n, Z and A are defined as above for the compounds of formula VII' and R<sup>5</sup> is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

20 Preferred compounds of formula LXIII' include those compounds wherein G is H<sub>2</sub> and X' is H.

Preferred compounds of formula LXIV' are those compounds wherein X is a C<sub>1</sub> alkyl substituted with Ar, as defined above for compounds of Formula I', and D' is a C<sub>1</sub>-C<sub>4</sub> alkyl. Most preferably, X is benzyl and D' is i-Bu.

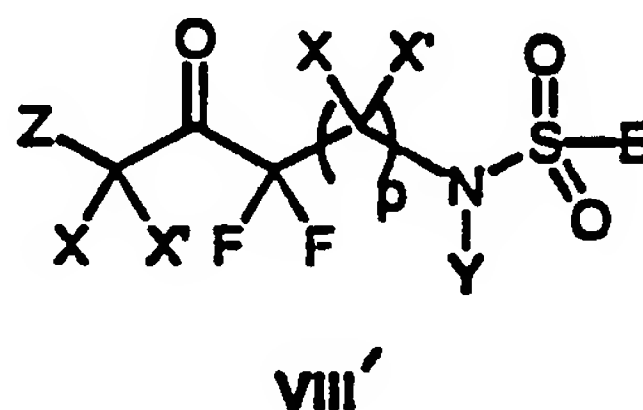
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Preferred compounds of formula II' include those compounds wherein X and X' on the carbon adjacent to the carbon bearing Z on the backbone, taken together, are oxygen. Other preferred compounds of formula II' are those compounds having the structure of

5 formula VIII':

Formula VIII':



wherein E, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, n, p, Y, D, Ar, Het, Z, A, X and X' are as defined above for compounds of formula II'. Except where expressly noted to the contrary, the

10 term for any given variable, the term "[variable]" defined as for a compound of formula VIII'" refers to the definition directly above.

Preferred compounds of formula VIII' include those compounds wherein on the carbon bearing Z, X is H and more preferably, X is H and X' is D. Preferred compounds of formula VIII' also include those compounds wherein E is a C<sub>6</sub>-C<sub>10</sub> aryl optionally substituted with OCH<sub>3</sub> or NH<sub>2</sub> and Z is (S)-THF-OC(O)NH- or 5-(1,3-

15 dioxanyl)-OC(O)NH-. Other preferred compounds of formula VIII' include those compounds wherein:

20

Y is H; and

X and X' on the carbon adjacent to N-Y are respectively D, preferably C<sub>1</sub>-C<sub>6</sub> alkyl and H.

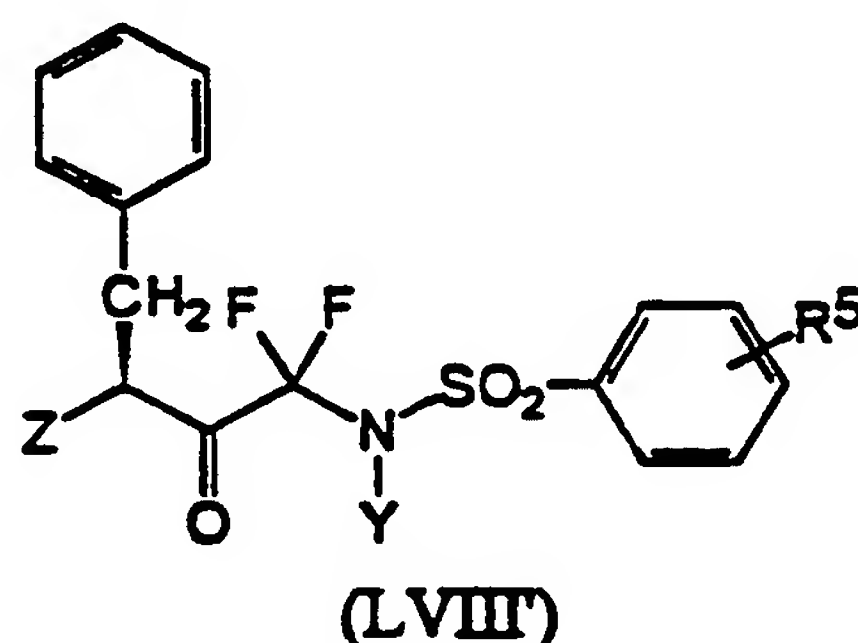
25 Other preferred compounds of formula VIII' include those wherein:

- 85 -

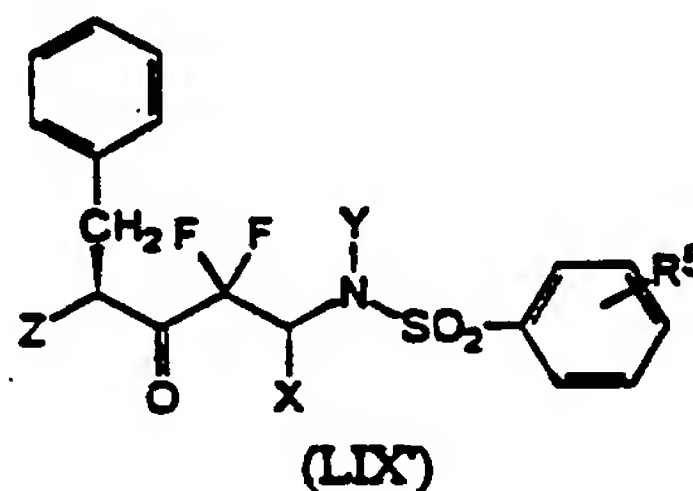
Y is D, preferably C<sub>1</sub>-C<sub>6</sub> alkyl; and  
X and X' on the carbon adjacent to N-Y are  
both hydrogen.

Other preferred compounds of formula VIII'  
5 are those compounds having the structure of formula  
LVIII' or LIX':

Formula LVIII':



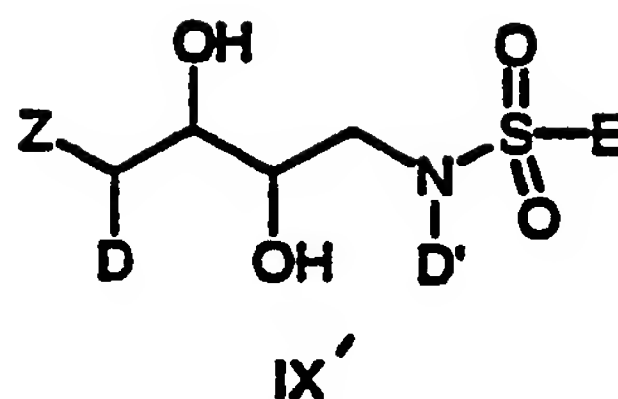
Formula LIX':



10 wherein R<sup>2</sup>, R<sup>3</sup>, n, Y, D, Ar, Het, and X are as defined  
above for compounds of formula VIII' and R<sup>5</sup> is selected  
from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>,  
-N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-  
N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

15 Preferred compounds of formula III' are those  
compounds having the structure of formula IX':

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Formula IX':

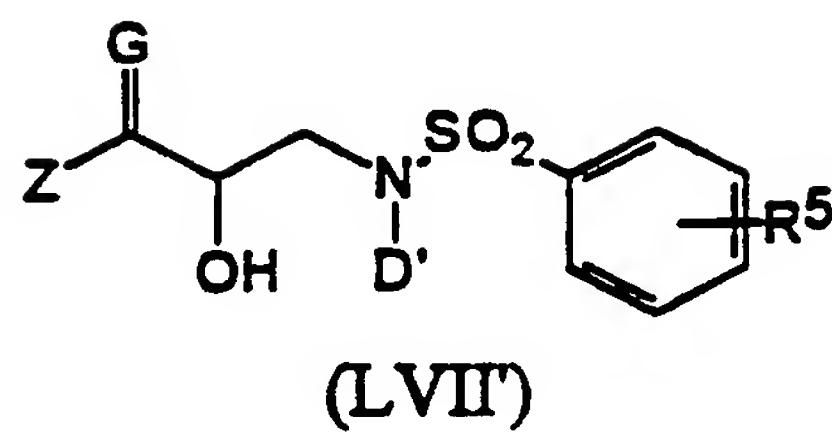
wherein D, D', Ar, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, Het, E, R<sup>4</sup>, n, Z and A are defined as above for the compounds of formula III'.

5 Preferred sulfonamides of this invention of formulas I', II' and III' include compounds having the general formulas contained in Tables 9 through 17. In each of these tables, R<sup>5</sup> may be selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>;  
 10 and


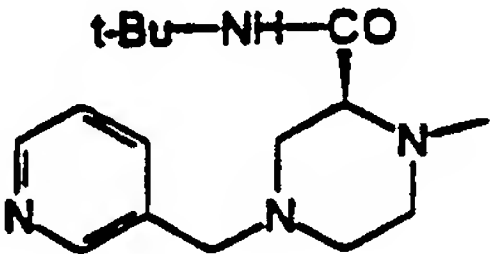
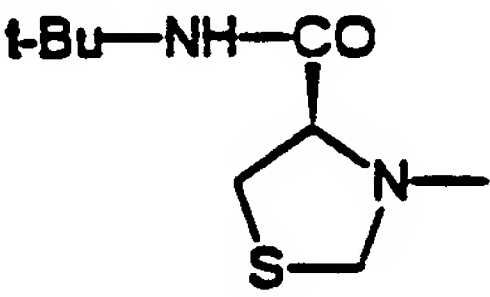
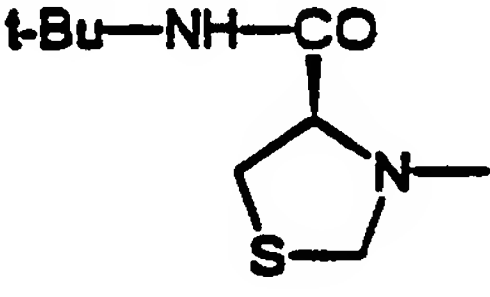
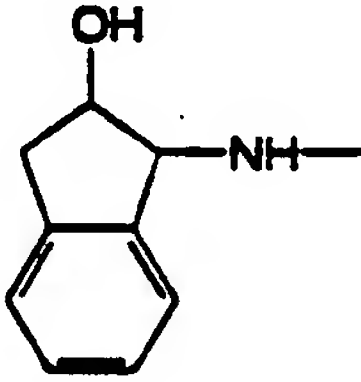
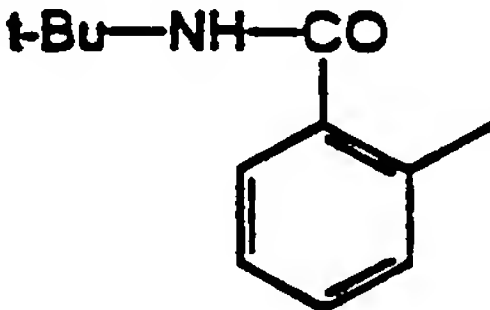
wherein R<sup>2</sup> is defined as above for compounds of formula I'.

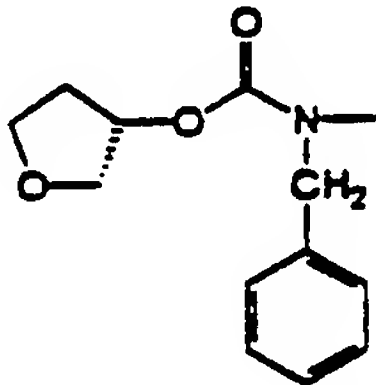
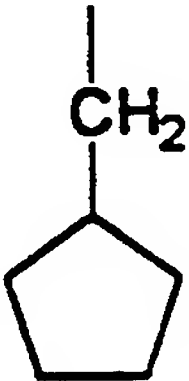
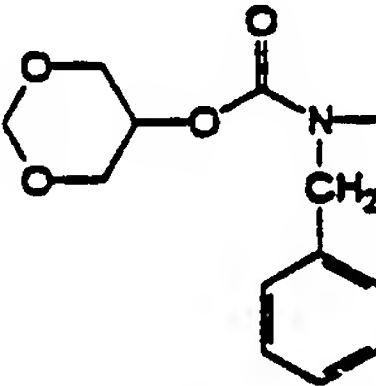
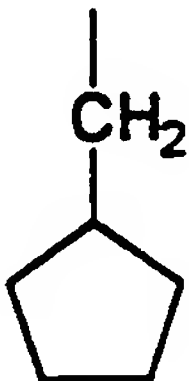
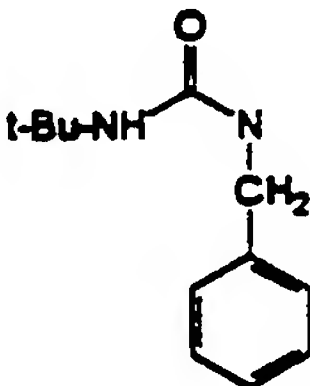
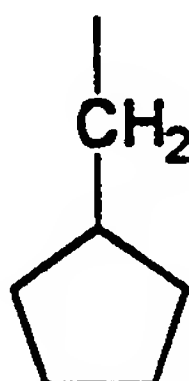
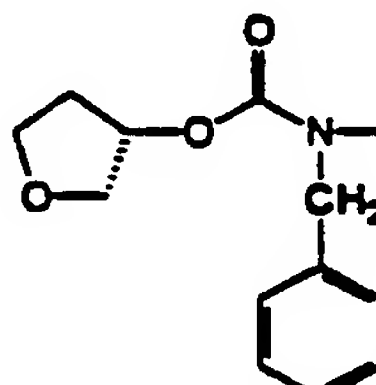
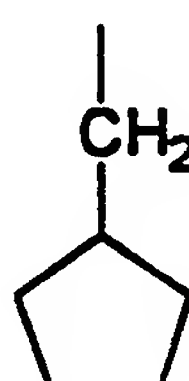
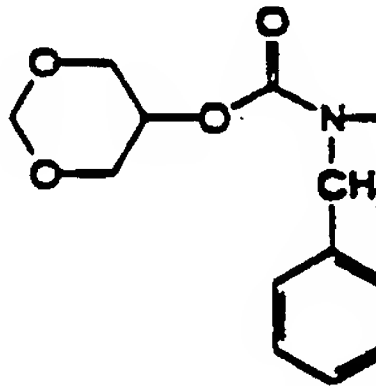
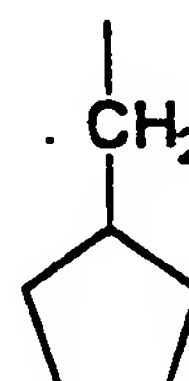
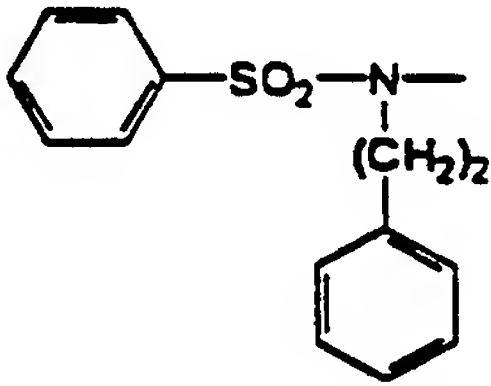
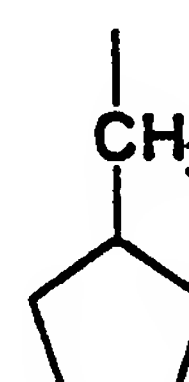
Preferably, at least three, and more preferably four or five, of the R<sup>5</sup> substituents are H.

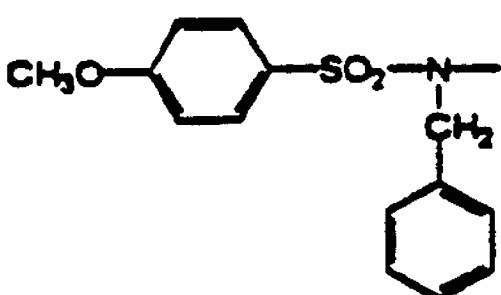
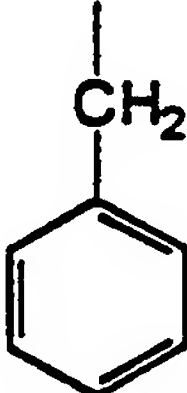
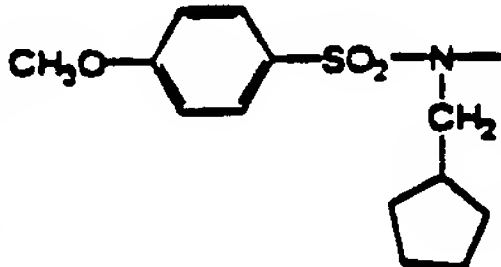
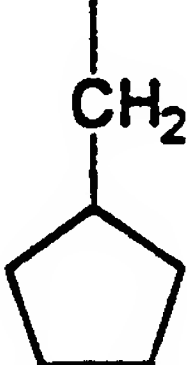
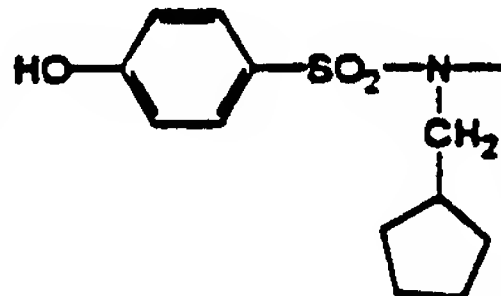
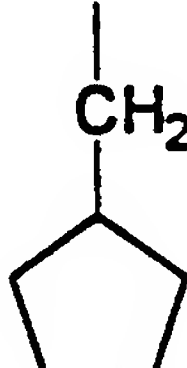
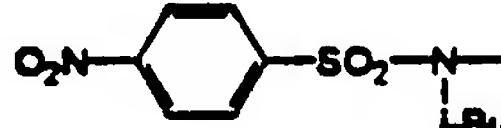
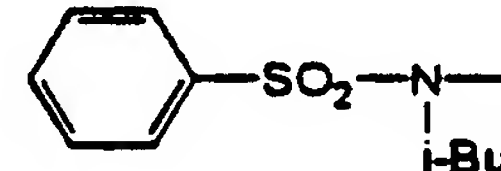
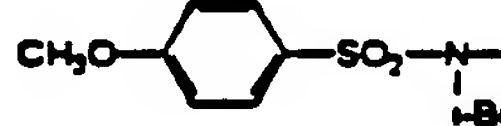
TABLE 9



COMPOUND	Z	G	D'
X'		H <sub>2</sub>	i-Bu
XI'		H <sub>2</sub>	i-Bu
XII'		H <sub>2</sub>	i-Bu
XIII'		H <sub>2</sub>	i-Bu
XIV'		H <sub>2</sub>	i-Bu

XV'		H <sub>2</sub>	i-Bu
XVI'		H <sub>2</sub>	i-Bu
XVII'		H <sub>2</sub>	i-Bu
XVIII'		O	i-Bu
XIX'		H <sub>2</sub>	i-Bu
XX'		H <sub>2</sub>	i-Bu

XXI'		H <sub>2</sub>	
LXV'		H <sub>2</sub>	
XXII'		H <sub>2</sub>	
XXIII'		H <sub>2</sub>	
LXVI'		H <sub>2</sub>	
XXIV'		H <sub>2</sub>	

XXV'		H <sub>2</sub>	
XXVI'		H <sub>2</sub>	
XXVII'		H <sub>2</sub>	
XXVIII'		H <sub>2</sub>	i-Bu
XXIX'		H <sub>2</sub>	i-Bu
XXX'		H <sub>2</sub>	i-Bu

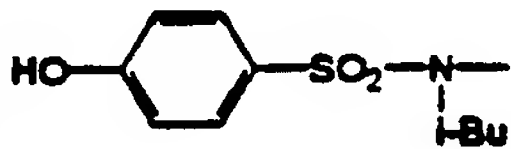
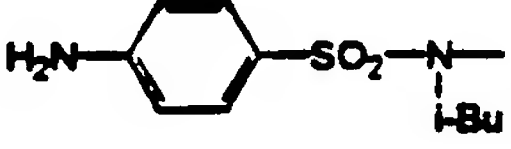
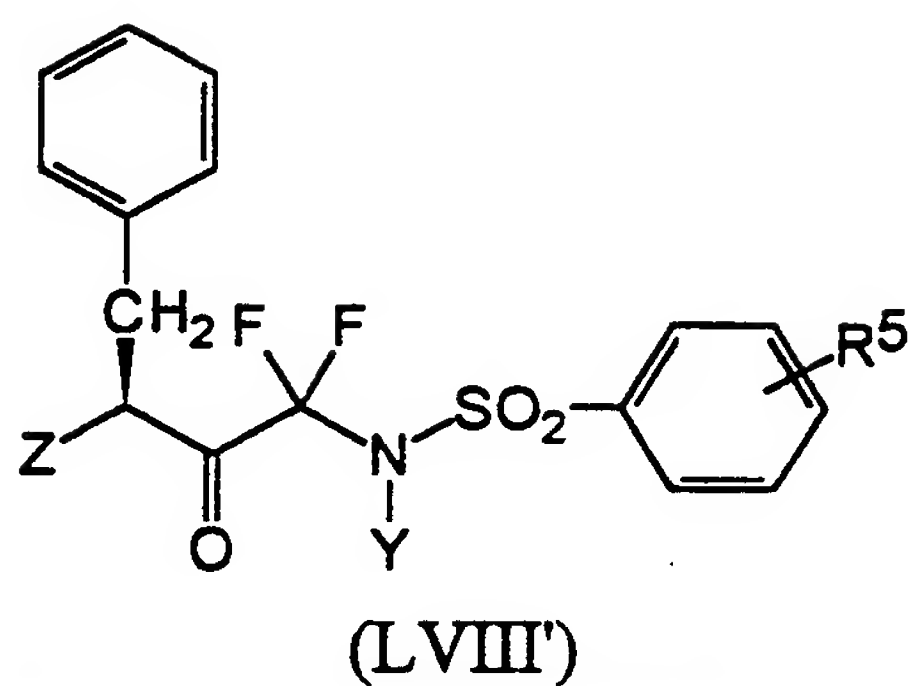
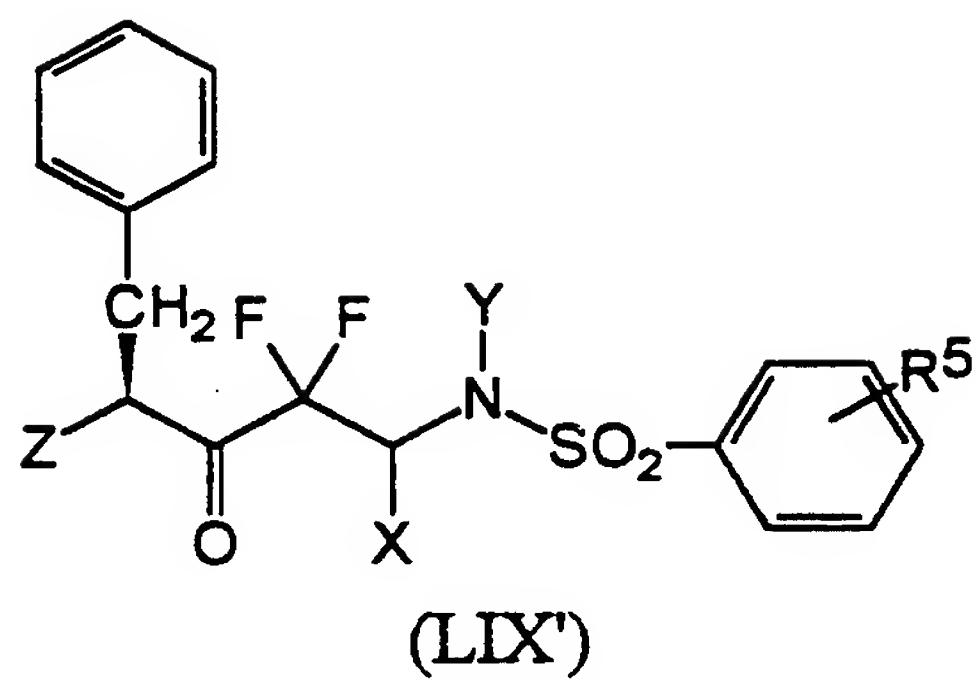
XXXI'		H <sub>2</sub>	i-Bu
XXXII'		H <sub>2</sub>	i-Bu

TABLE 10



COMPOUND	Z	Y
XXXIII'		
LXVII'		

TABLE 11



COMPOUND	Z	X	Y
XXXIV'			H
LXVIII'			H
XXXV'		H	

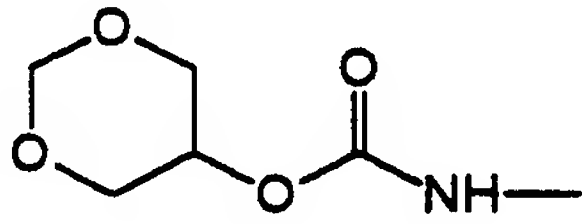
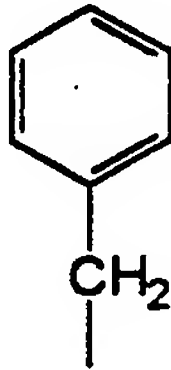
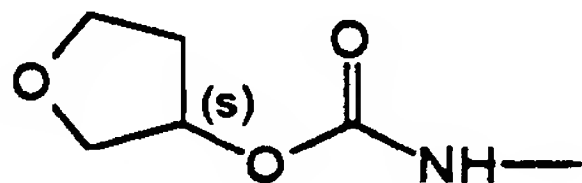
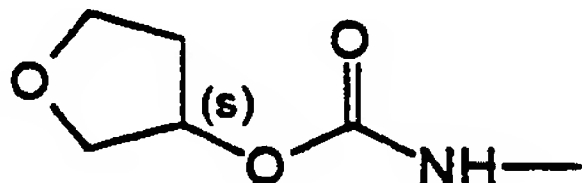
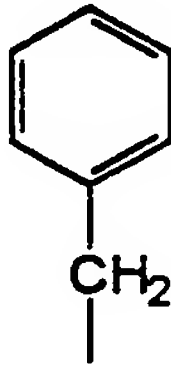
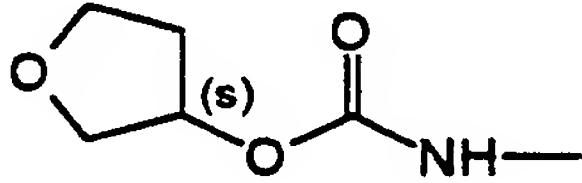
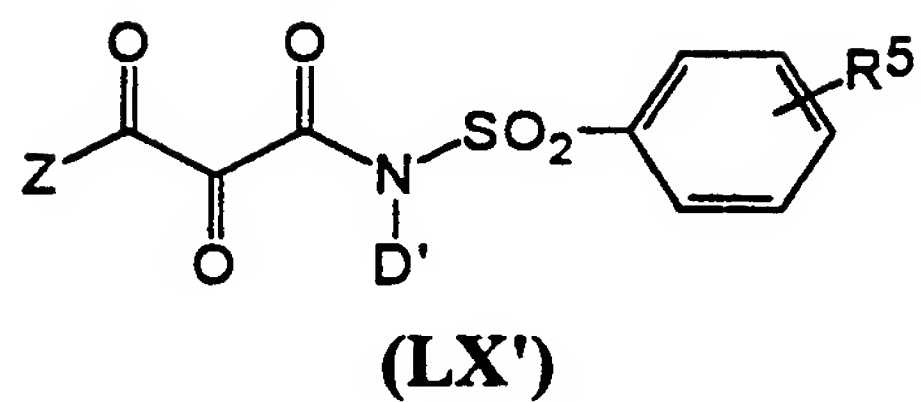
LXIX''		H	
La'		H	i-Bu
Lb'		H	
Lc'		i-Bu	H

TABLE 12



COMPOUND	Z	D'
XXXVI'		
XXXVII'		
XXXVIII'		i-Bu

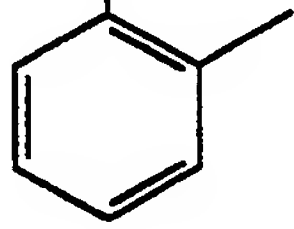
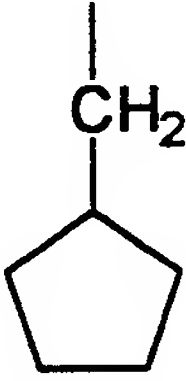
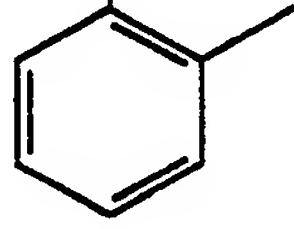
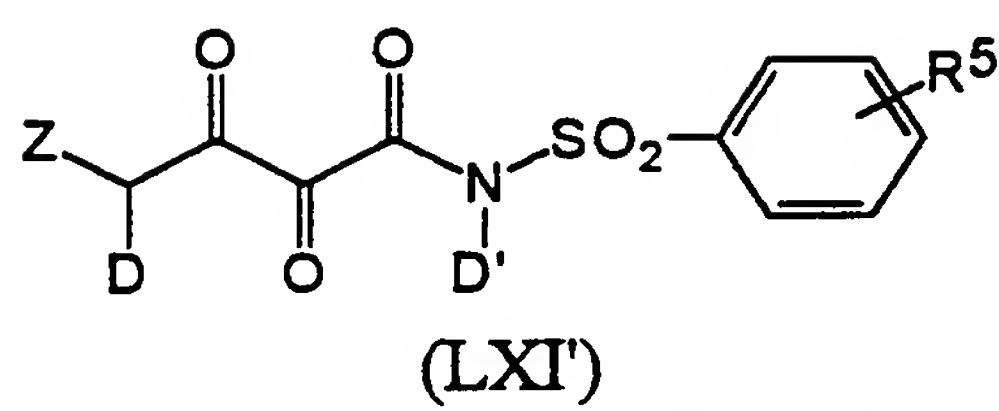
XXXIX'	$\text{t-Bu-NH-CO}$ 	$\text{CH}_2$ 
LVI'	$\text{t-Bu-NH-CO}$ 	i-Bu

TABLE 13



COMPOUND	Z	D	D'
XL'			
LXX'			
LXXI'			
LIV'			i-Bu

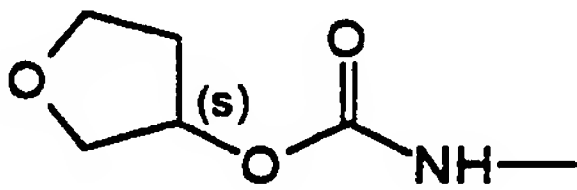
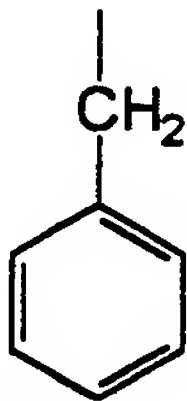
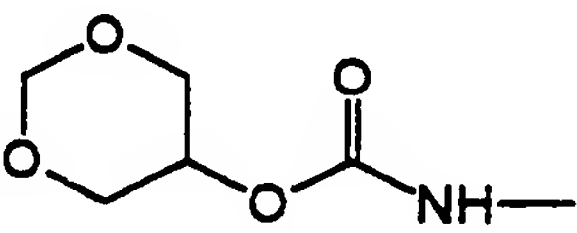
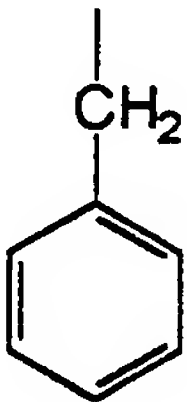
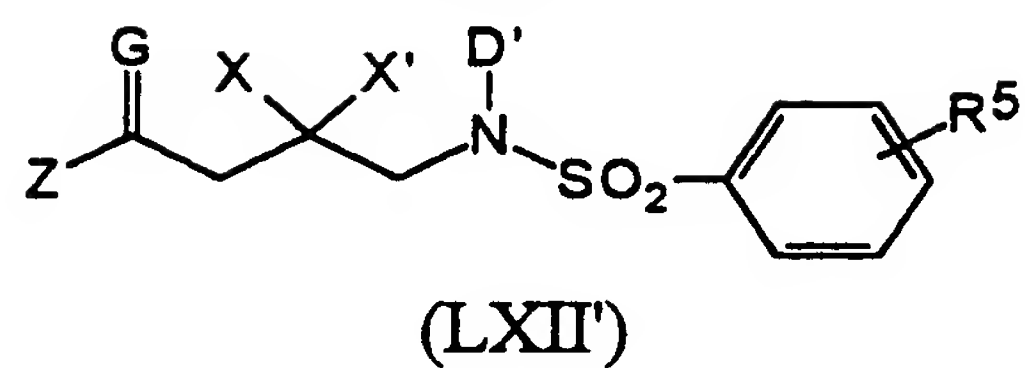
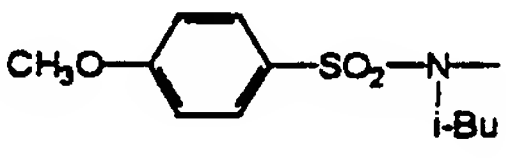
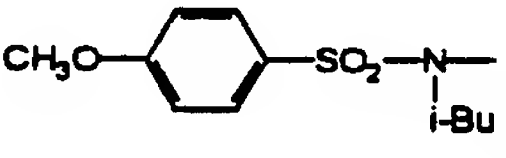
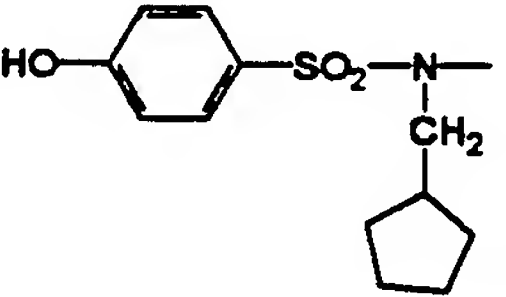
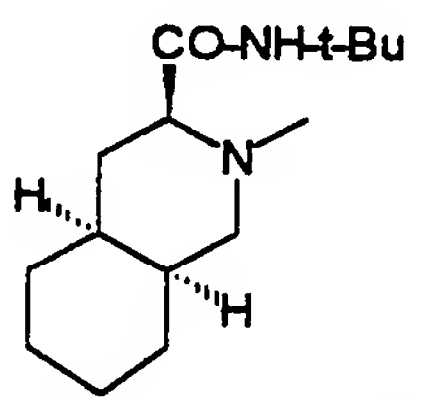
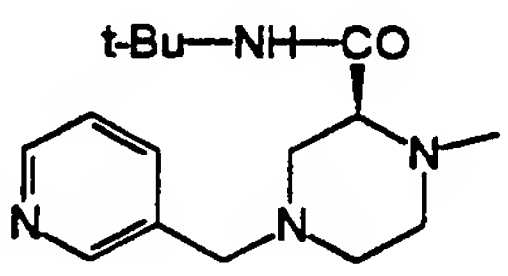
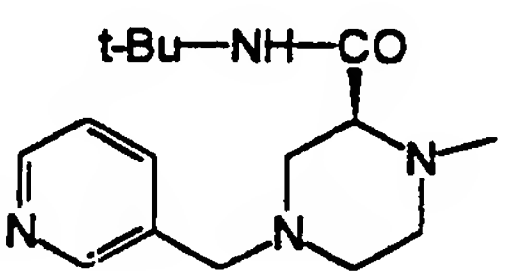
LXXII'			i-Bu
LXXIII'			i-Bu

TABLE 14

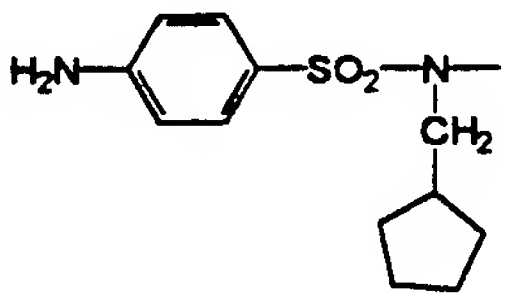
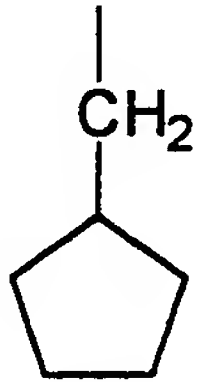
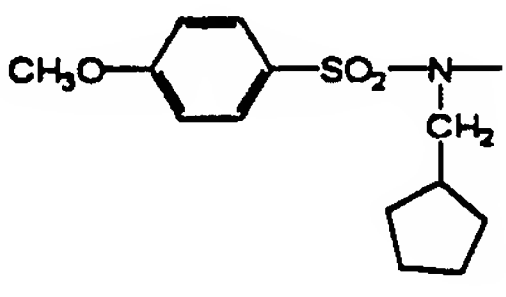
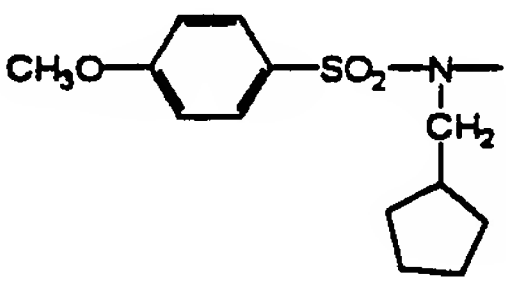


COMPOUND	Z	G	X	X'	D'
XLII'		H <sub>2</sub>	OH	H	i-Bu
XLII'		O	OH	H	i-Bu
LXXXV'		H <sub>2</sub>	OH	H	i-Bu
XLIII'		H <sub>2</sub>	OH	H	i-Bu

- 100 -

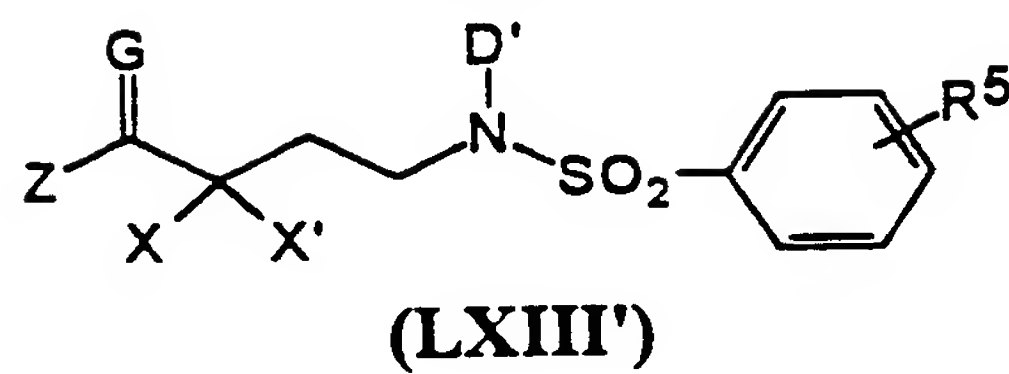
XLIVa'		H <sub>2</sub>	OH	H	i-Bu
XLIVb'		H <sub>2</sub>	OH	H	i-Bu
XLV'		H <sub>2</sub>	OH	H	i-Bu
XLV□I'		H <sub>2</sub>	OH	H	i-Bu
XLV□II'		H <sub>2</sub>	OH	H	i-Bu
LXXXIII'		O	OH	H	i-Bu

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XLIX'		H <sub>2</sub>	OH	H	
LVa'		H <sub>2</sub>	OH	H	i-Bu
LVb'		H <sub>2</sub>	OH	H	i-Bu

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TABLE 15



COMPOUND	Z	G	X	X'	D'
XLVIII'		H <sub>2</sub>	OH	H	i-Bu
LXXIV'		H <sub>2</sub>	OH	H	i-Bu
LXXV'		H <sub>2</sub>	OH	H	i-Bu

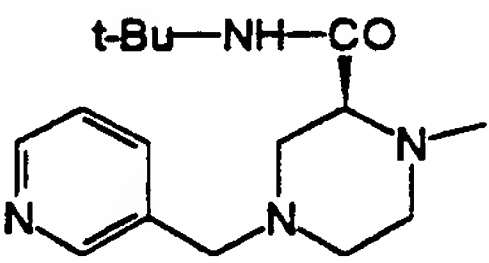
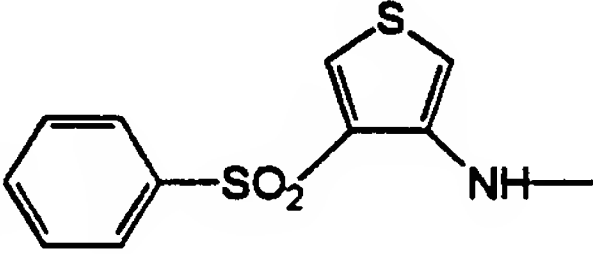
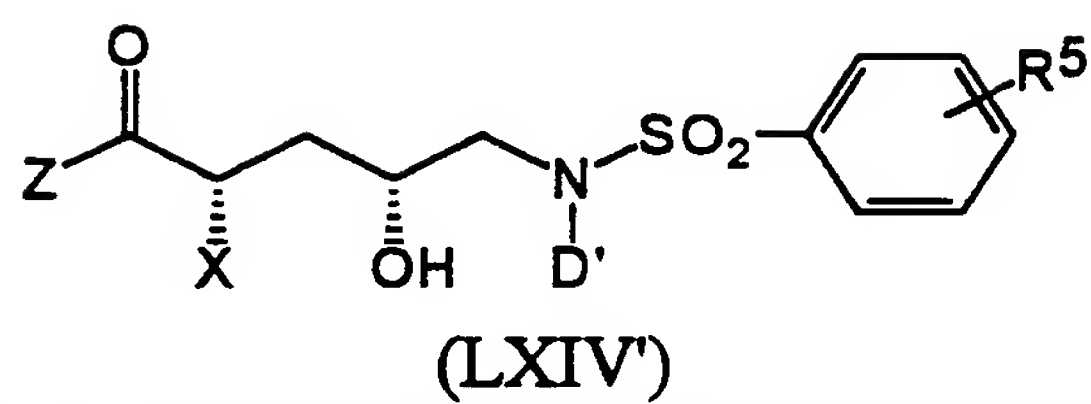
LXXVI'		H <sub>2</sub>	OH	H	i-Bu
LXXVII'		H <sub>2</sub>	OH	H	i-Bu

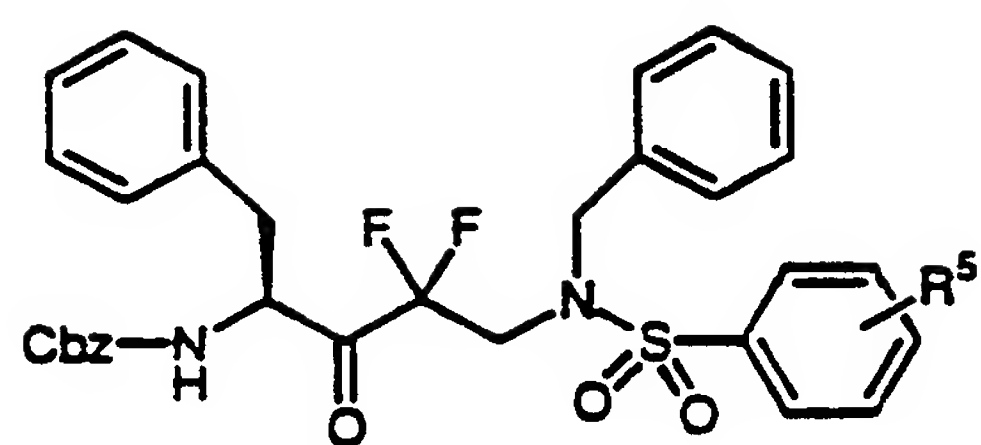
TABLE 16



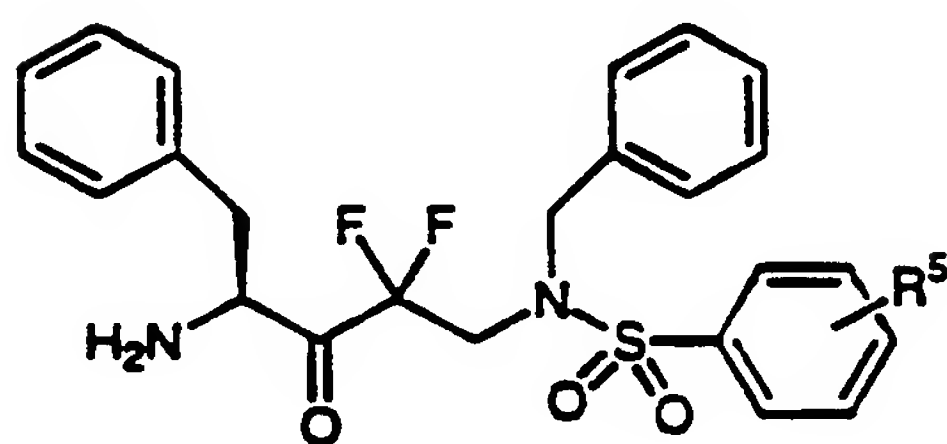
COMPOUND	Z	X	D'
LI'	i-Bu-NH		i-Bu
LII'			i-Bu
LIII'			i-Bu

105

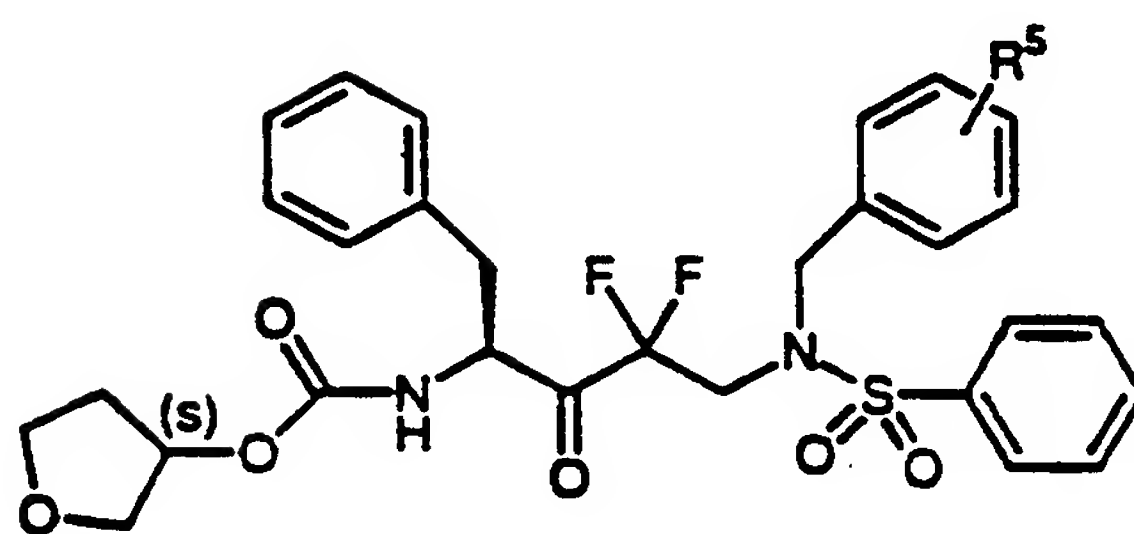
TABLE 17



Ld'

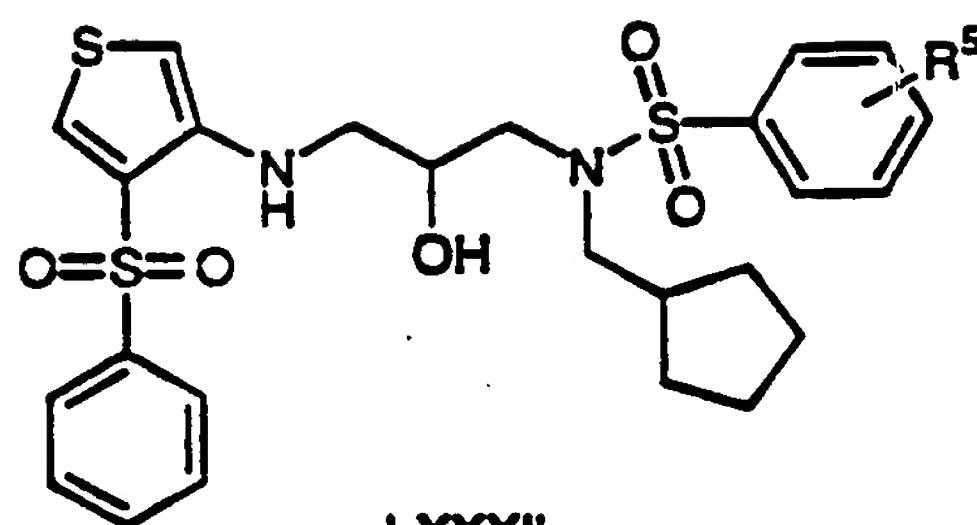


Le'



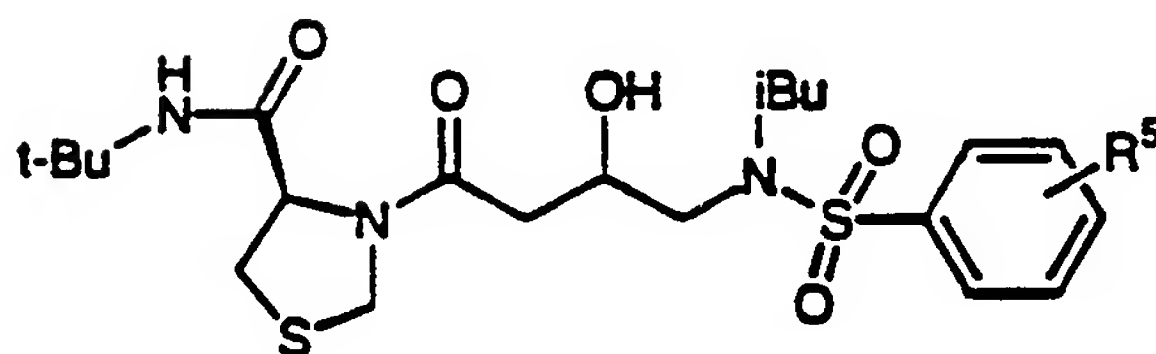
Lf'

106



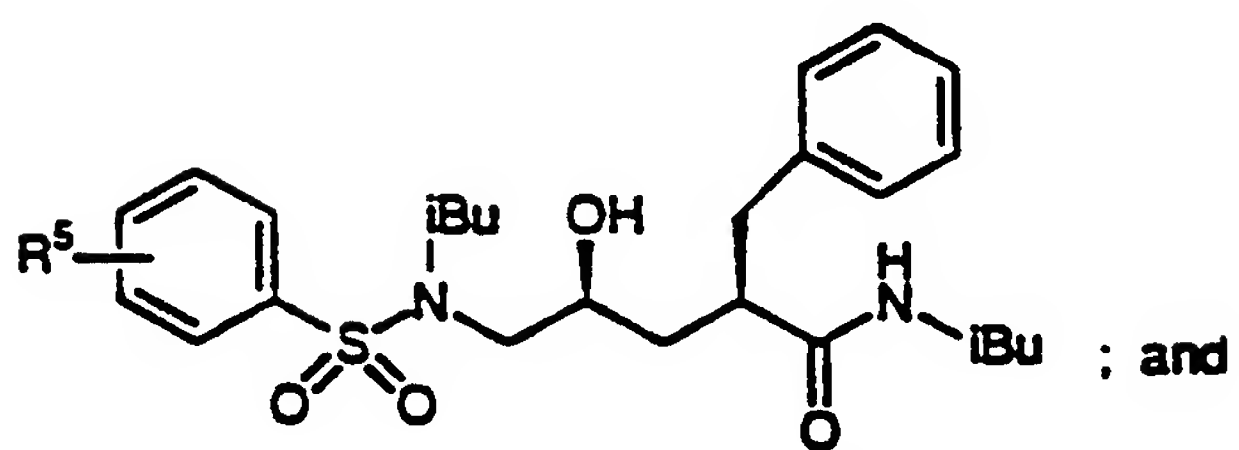
LXXXI'

;



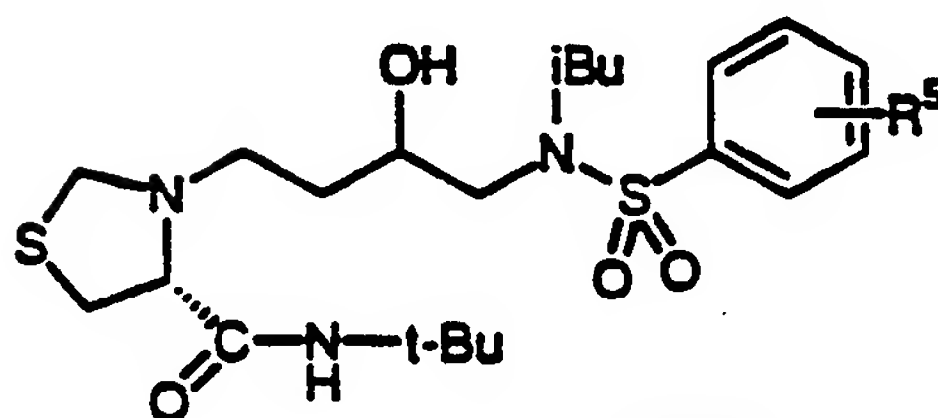
LXXXII'

;



LXXXIV'

; and



LXXXV'

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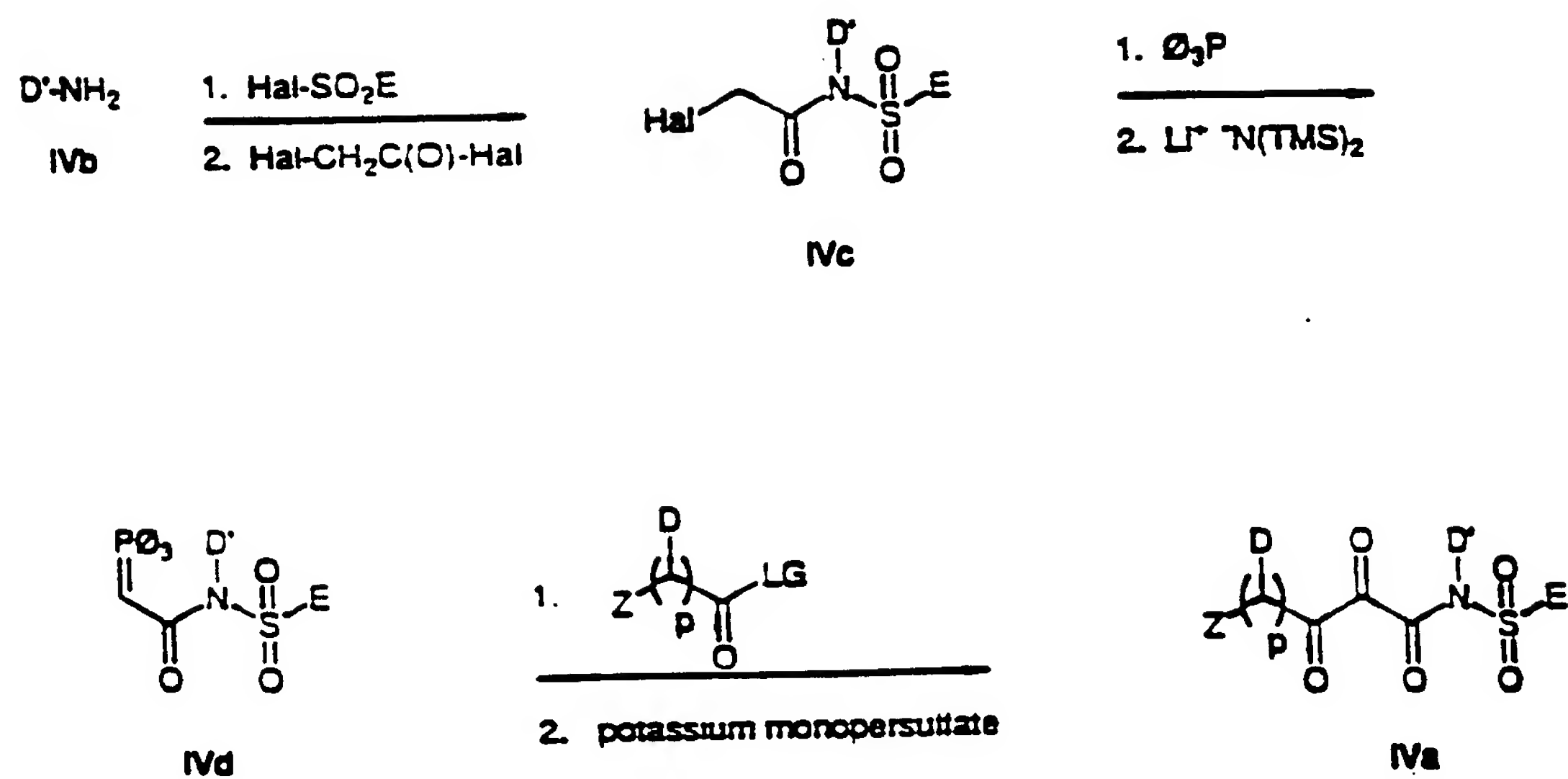
The sulfonamides of this invention may be synthesized using conventional techniques.

Advantageously, these compounds are conveniently synthesized from readily available starting materials.

5           The compounds of this invention are among the most readily synthesized HIV protease inhibitors known. Previously described HIV protease inhibitors often contain four or more chiral centers and numerous peptide linkages. The relative ease with which the  
10       compounds of this invention can be synthesized represents an enormous advantage in the large scale production of these compounds. Although the syntheses of the sulfonamides of this invention are known to those of skill in the art, the following general  
15       schemes are set forth to illustrate these methods. These schemes should not be viewed as limiting the scope of this invention in any way.

          Using standard techniques, compounds of the present invention having the general formula IVa may be  
20       obtained as described in Scheme 1:

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Scheme 1

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Primary amine IVb, wherein D' is defined as above for the compounds of formula I, may be converted to the N-acylsulfonamide of formula IVc, first by sulfonylating with a sulfonyl halide having the general formula Hal-SO<sub>2</sub>E, wherein Hal is any halogen and E is defined as above for the compounds of formula I, and then by N-acylating with a haloacetyl halide having the general formula Hal-CH<sub>2</sub>-C(O)Hal, wherein Hal is defined above.

Preferred sulfonylating agents have the general structure Cl-SO<sub>2</sub>E, wherein E is defined as above for the compounds of formula I. The sulfonylation reaction may optionally take place in the presence of a base to scavenge the hydrohalic acid product as a reaction byproduct. Such bases include, but are not limited to triethylamine, pyridine, 4-dimethylaminopyridine, sodium bicarbonate and potassium carbonate. We prefer using sodium bicarbonate.

The resulting sulfonamide is then N-acylated with a haloacetyl halide having the general formula Hal-CH<sub>2</sub>-C(O)Hal, wherein Hal is defined as above, to give the N-acylsulfonamide of formula IVc. Haloacetyl halides include bromoacetyl bromide, chloroacetyl chloride and preferably, bromoacetyl chloride. The acylation reaction is preferably run in the presence of a base strong enough to deprotonate the sulfonamide nitrogen prior to N-acylation. Preferred bases include lithium diisopropyl amide and potassium bis(trimethylsilyl)amide. We especially prefer lithium bis(trimethylsilyl)amide.

The N-acylsulfonamide of formula IVc is then converted to its ylide derivative of formula IVd, wherein D' and E are defined as for the compounds of formula I, first by treating the compound of formula IVc with triphenylphosphine to form the phosphonium

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halide salt, and then by deprotonating the phosphonium  
halide salt with a strong base to form the ylide of  
formula IVd. Such strong bases include, but are not  
limited to lithium diisopropyl amide, potassium  
5 bis(trimethylsilyl)amide and lithium  
bis(trimethylsilyl)amide. We prefer to deprotonate the  
phosphonium halide salt with lithium  
bis(trimethylsilyl)amide.

The ylide IVd is then converted to  
10 tricarbonyl IVa by a two-step acylation/oxidation  
process. The procedure for carrying out such a process  
is described in Wasserman et al., J. Org. Chem., 58,  
pp. 4785-87 (1993) and references cited therein. Ylide  
IVd is first acylated with Z-(CHD)<sub>p</sub>C(O)-LG, wherein Z, D  
15 and p are defined above as for compounds of formula I  
and LG is any conventional leaving group. Suitable  
leaving groups include, but are not limited to,  
hydroxyl, carboxylates and halides. Preferably, the  
leaving group is either hydroxyl or halide, most  
20 preferably chloride. Acylation reactions of this type  
may optionally be run in the presence of a base.

When the leaving group in the acylation  
reaction is halide, suitable bases include, but are not  
limited to triethylamine, pyridine, 4-  
25 dimethylaminopyridine, sodium bicarbonate, potassium  
carbonate and preferably, bis(trimethylsilyl)acetamide.  
When the leaving group is hydroxyl, dehydrating agents  
such as (1-(3-dimethylaminopropyl)-3-ethylcarbodiimide  
and dicyclohexylcarbodiimide may be optionally used to  
30 facilitate acylation. We prefer to use (1-(3-  
dimethylaminopropyl)-3-ethylcarbodiimide.

The product of the acylation step is treated  
with an oxidizing agent to give, after rearrangement,  
triphenylphosphine oxide and tricarbonyl compound IVa,  
35 wherein Z, D, p, D' and E are defined as above for

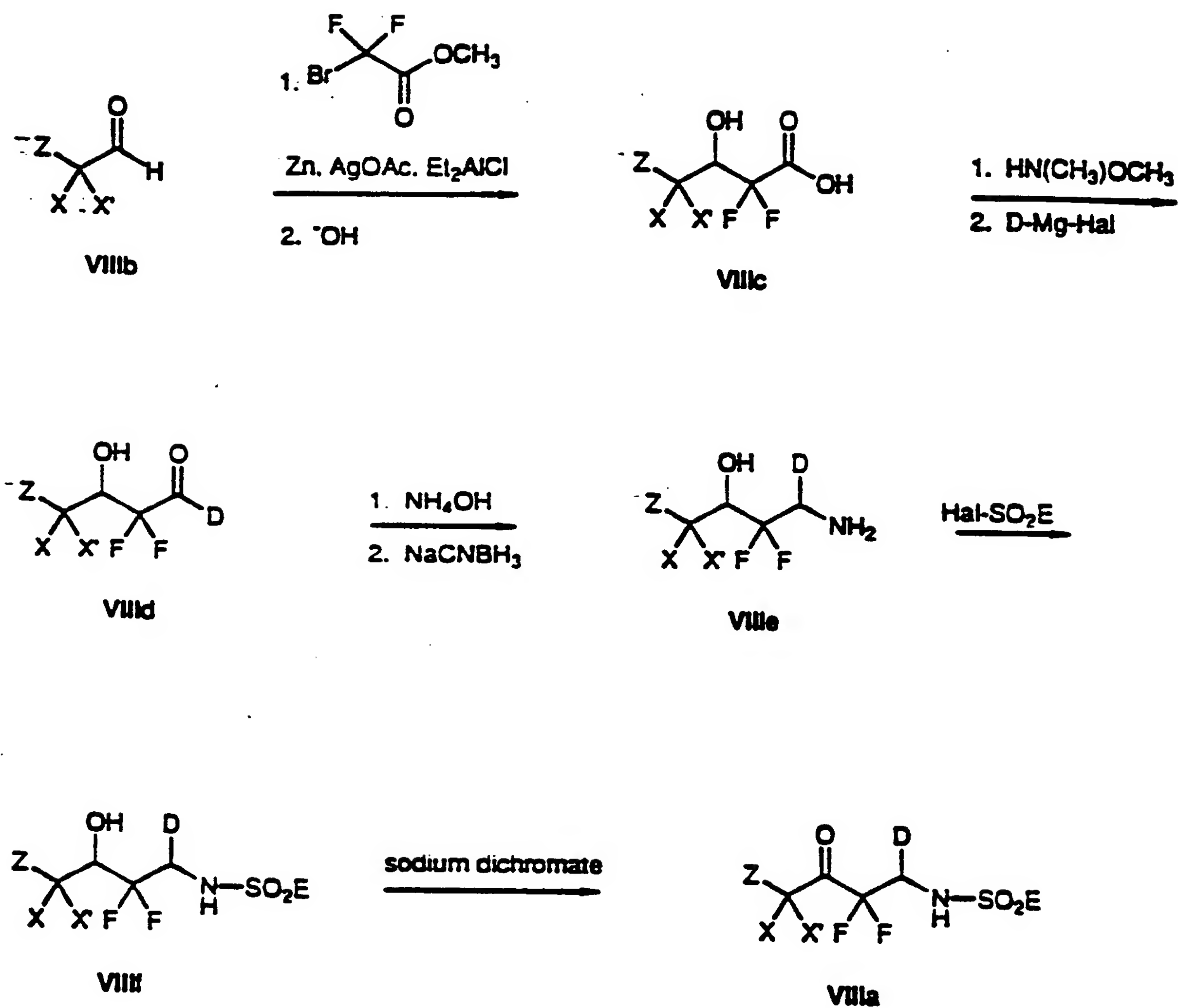
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compounds of formula I. Suitable oxidizing agents include, but are not limited to hydrogen peroxide, organic peracids such as peracetic acid and m-chloroperbenzoic acid, sodium hypochlorite and preferably, Oxone® (a commercially available mixture of potassium monopersulfate, potassium sulfate and potassium bisulfate).

Compounds of Formula IVa and other compounds of this invention having three adjacent carbonyls on their backbone structures may optionally be hydrated at the central carbonyl. Methods to hydrate or prevent hydration of this central carbonyl are known to those of ordinary skill in the art.

Compounds of the present invention having the general formula VIIa may be obtained by the synthesis described in Scheme 2a:

- 112 -



Scheme 2a

- 113 -

Aldehyde VIIIB is converted to difluoroacid VIIIC, wherein Z, X and X' are defined as above for compounds of formula II, first by condensing the aldehyde with methyl difluorobromoacetate in the presence of zinc, silver(I) acetate and diethylaluminum chloride to give a difluoro methyl ester (as described in T.T. Curran, J. Org. Chem., 58, pp. 6360-63 (1993)) and then hydrolyzing the methyl ester to a carboxylic acid. The present invention envisions the use of either acidic or basic hydrolysis. Bases which may be employed include potassium hydroxide, lithium hydroxide and sodium hydroxide. We prefer basic hydrolysis using sodium hydroxide.

Acid VIIIC is then converted to ketone VIIID, wherein D, X and X' are defined as above for compounds of formula II, via an N-methoxy-N-methylamide which is obtained by treating the acid with N-methoxy-N-methylamine. The N-methoxy-N-methylamide is then treated with a Grignard reagent of the general formula D-Mg-Hal, wherein D is defined as above for compounds of formula II and Hal is any halogen. Preferably, the halogen is chloride or bromine.

Ketone VIIID is then converted to primary amine VIIIE, wherein Z, X, X' and D are defined as above for compounds of formula II, first by forming an imine with an ammonia equivalent and then by reducing the imine to a primary amine. To form the imine, liquid ammonia or preferably, ammonium hydroxide may be used. The reduction of the imine may be carried out using any conventional hydride, but preferably using sodium cyanoborohydride. One convenient reduction scheme is the Borch reduction described in R.F. Borch et al., J. Amer. Chem. Soc., 93, pp. 2897-904 (1971).

The primary amine VIIIE is then sulfonylated with a sulfonyl halide having the general formula Hal-

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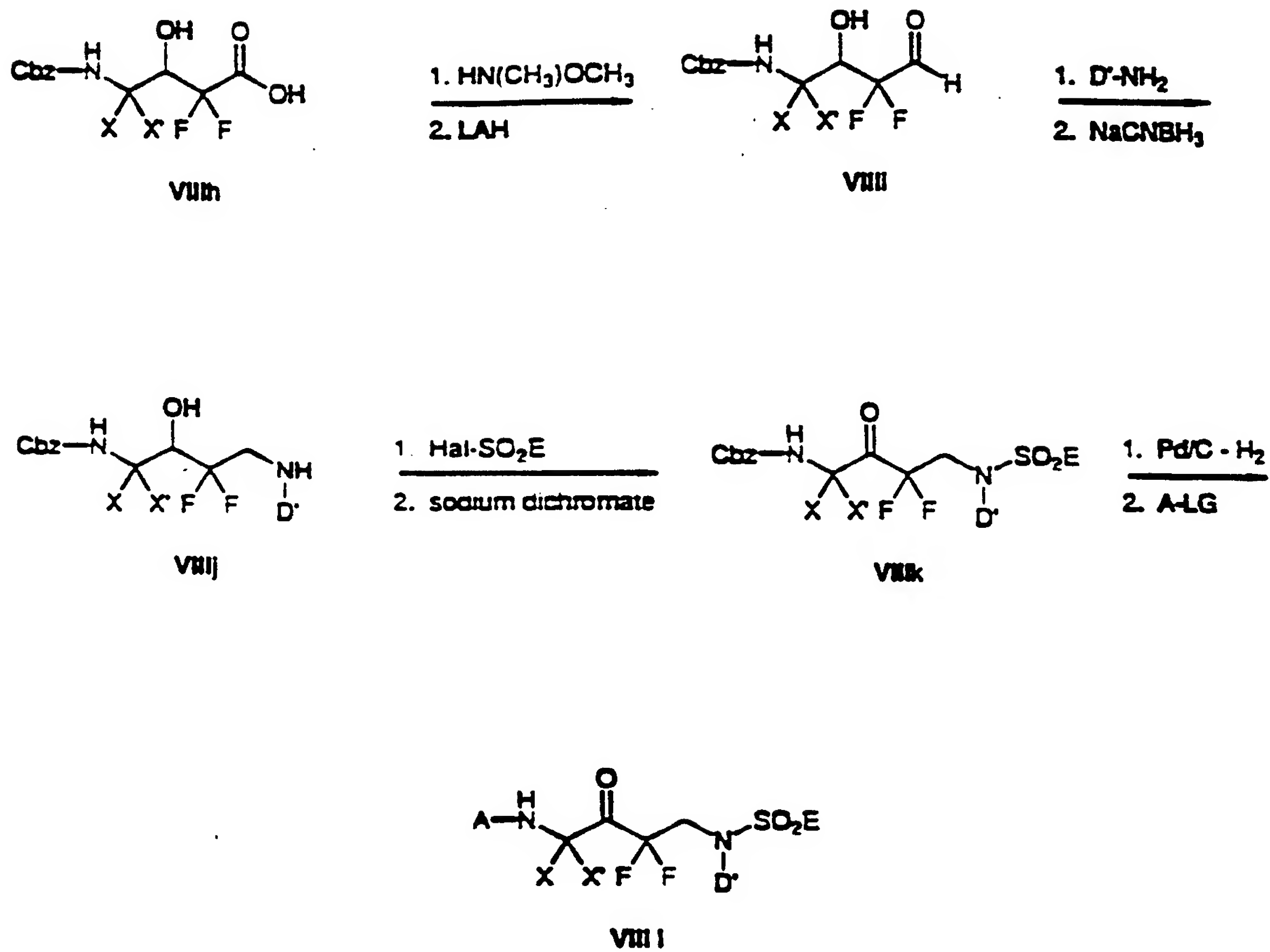
SO<sub>2</sub>E, wherein Hal is any halogen and E is defined as above for compounds of formula II, to give hydroxysulfonamide VIIIf, wherein Z, X, X', D and E are defined as above for compounds of formula II.

5 Preferably, Hal is chloride.

The hydroxysulfonamide VIIIf is then oxidized to give compounds of the general structure VIIIfa, wherein Z, X, X', D and E are defined as above for the compounds for formula II. Typical oxidizing agents  
10 include, but are not limited to, pyridinium dichromate, pyridinium chlorochromate, and dimethylsulfoxide/triethylamine/oxalyl chloride (Swern oxidation conditions). Preferably, the oxidizing agent is sodium dichromate.

15 Compounds of the present invention having the general formula VIIIf may be obtained by the synthetic route described below in Scheme 2b:

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Scheme 2b

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Carboxylic acid VIIIh, wherein X and X' are defined as in formula II, is reduced to aldehyde VIIIi, wherein X and X' are defined as in formula II, first by forming an amide with N-methoxy-N-methylamine and then by reducing the amide to give aldehyde VIIIi. Suitable reducing agents include, but are not limited to sodium borohydride, sodium cyanoborohydride, lithium and potassium tri-sec-butylborohydride and preferably, lithium aluminum hydride.

Aldehyde VIIIi is then treated with a primary amine having the general formula D'-NH<sub>2</sub>, wherein D' is defined the same as D above for compounds of formula II (as used throughout this scheme, D' will be defined as D above for compounds of formula II), to give an imine which is reduced to give a secondary amine having the general formula VIIIj, wherein X and X' are defined as above for the compounds of formula II and D' is defined as above. The reducing agent which is used can be essentially any hydride reducing agent known to those skilled in the art, preferably, sodium cyanoborohydride.

Secondary amine VIIIj is then sulfonylated with a sulfonylating agent having the general formula Hal-SO<sub>2</sub>E, wherein Hal is any halogen and E is defined above for the compounds of formula II and then oxidized to give N-Cbz ketone of the formula VIIIk, wherein X, X' and E are defined as above for compounds of formula II and D' is defined in the preceding paragraph. Suitable oxidizing agents include, but are not limited to pyridinium dichromate, pyridinium chlorochromate, dimethyl sulfoxide/triethylamine/oxalyl chloride (Swern oxidation conditions) and preferably, sodium dichromate.

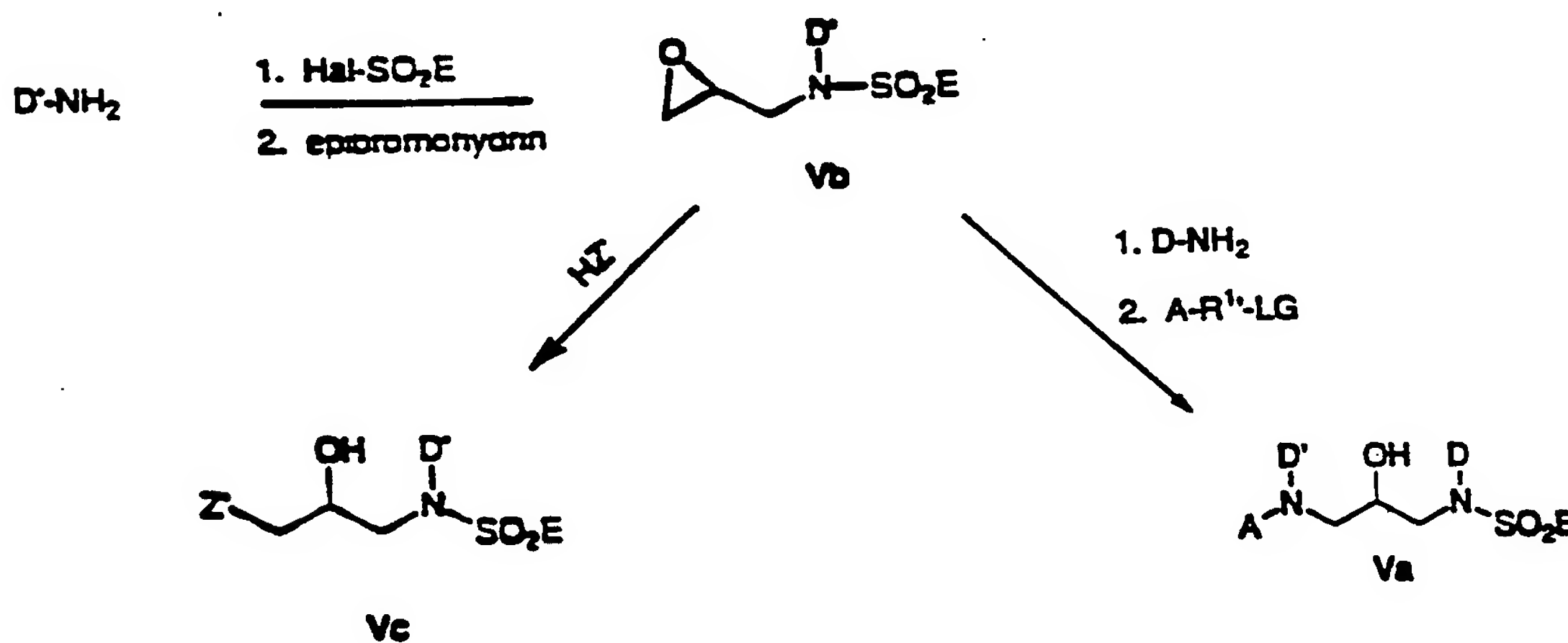
Ketone VIIIk is then reduced with hydrogen in the presence of Pd/C catalyst to remove the Cbz group,

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and then acylated or sulfonylated with A-LG, wherein A is defined as above for compounds of formula II and LG is a suitable leaving group. Suitable leaving groups include, but are not limited to, halogen, hydroxyl, alkanoate, and preferably N-oxysuccinimide.

Preferred A-LG are 3-(S)-tetrahydrofuranyl succinamidyl carbonate and 1,3 dioxane-p-nitrophenyl carbonate. 1,3 dioxane-p-nitrophenyl carbonate is prepared according to Example 36 below. Treatment of VIIIk, as above, gives compound VIIIl, wherein A, X, X' and E are defined as above for compounds having the formula II and D' is defined as in the preceding paragraph.

Compounds of the present invention having the general formula Va and Vc may be obtained by the steps shown below in Scheme 3:



Scheme 3

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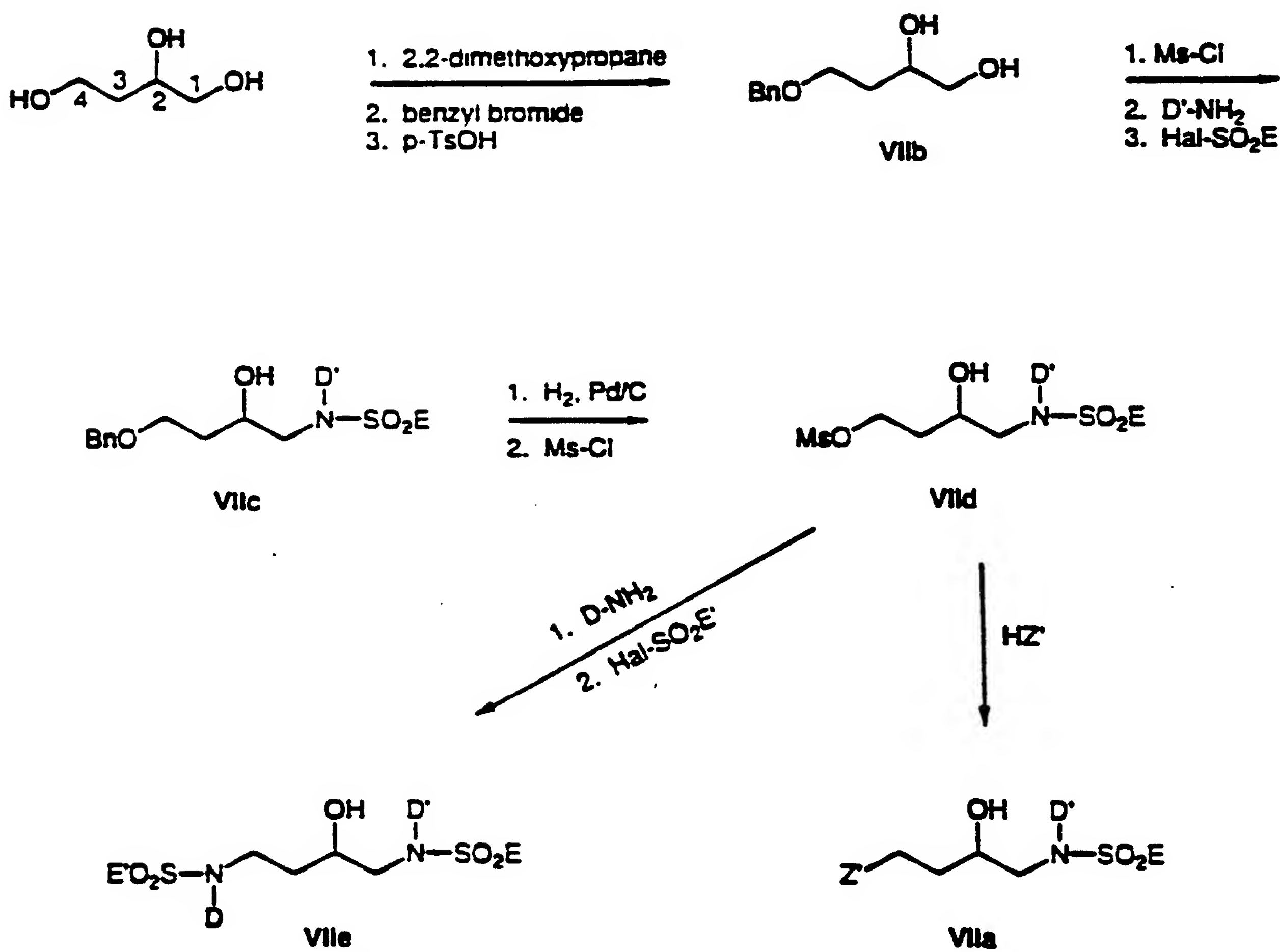
A primary amine having the general formula  $D'-NH_2$ , wherein  $D'$  is defined as for compounds of formula I, is sulfonylated with a sulfonyl halide having the general formula  $Hal-SO_2E$ , wherein  $Hal$  is any halogen and  $E$  is defined as above for compounds of formula I, to give a sulfonamide, which in turn is alkylated with an epihalohydrin, or if a enantiomerically pure product is desired, a chiral glycidyl derivative to give epoxide Vb. Suitable epihalohydrins include, but are not limited to, epichlorohydrin, epiodohydrin and preferably, epibromohydrin. Suitable chiral glycidyl derivatives include, but are not limited to, (2S)-(+)- and (2R)-(-)-glycidyl tosylate and (2S)-(+)- and (2R)-(-)-glycidyl 3-nitrobenzenesulfonate.

Epoxide Vb is then selectively ring-opened with a primary amine having the general formula  $D-NH_2$ , wherein  $D$  is defined as above for compounds of formula I, to give a diamine which is then acylated at the secondary amine position to give compound Va. The acylating agent has the formula  $A-R^{1'}-LG$ , wherein  $A$  is as defined above for compounds of formula I,  $R^{1'}$  is selected from the group consisting of  $-C(O)-$ ,  $-O-C(O)-$  and  $-NR^2-C(O)-$  and  $LG$  is as defined above.

Alternatively, epoxide Vb may be ring-opened with an amino species  $HZ'$ , wherein  $Z'$  is  $-N(D)SO_2E$ ,  $-N(H)A$ ,  $-N(D)A$ ,  $-N(H)E$ ,  $-N(H)C(O)N(D)(E)$ ,  $-N(H)Het$ ,  $-N(D)Het$  and  $-Het'$ , wherein  $D$ ,  $E$ ,  $Het$  and  $A$  are defined above as in formula I and  $-Het'$  is a 5-10 membered nitrogen-containing heterocycle optionally substituted with any of the  $Het$  substituents mentioned for compounds of formula I. Alkylation of Vb with  $HZ'$  gives compounds of the general formula Vc, wherein  $Z'$  is defined as above and  $D'$  and  $E$  are defined as above for compounds of formula I.

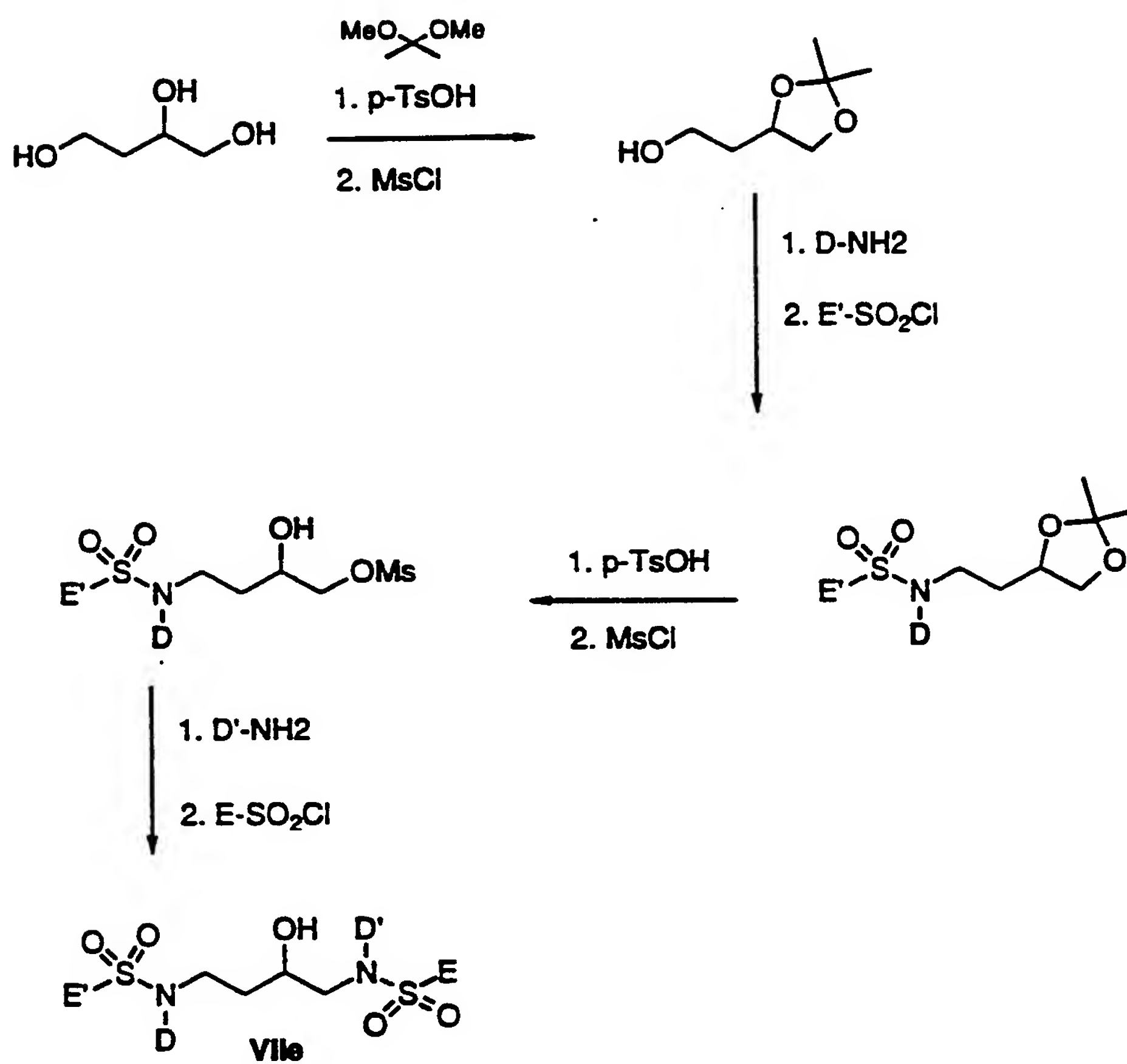
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Compounds of the present invention having the general formulas VIIa and VIIe are obtained by the methods described below in Scheme 4 and 4a:



Scheme 4

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Scheme 4a

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1,2,4-Butanetriol is ketalized with any suitable ketone or ketone equivalent, such as a dialkylketal thereof, in the presence of a protic acid, to give a primary alcohol bearing a ketal at the 1 and 2 positions. Such ketones, ketone equivalents, and protic acids are known to those of ordinary skill in the art. A preferred ketone is acetone, a preferred ketone equivalent is 2,2-dimethoxypropane and a preferred protic acid is p-toluenesulfonic acid. The primary alcohol is then protected with any conventional acid-stable protecting group. Examples of such protecting groups can be found, for example, in T.W. Greene, Protective Groups in Organic Synthesis, John Wiley and Sons (1991). A preferred protecting group is benzyl bromide. The resulting benzyl ketal is then deprotected with any conventional protic acid to give the benzyl diol of formula VIIb. We prefer to use p-toluenesulfonic acid.

Diol VIIb is then activated at its primary hydroxyl site. Suitable activating reagents include, but are not limited to, p-toluenesulfonyl halides, trifluoromethanesulfonyl halides, 4-bromobenzenesulfonyl halides and preferably, methanesulfonyl halides. Preferably, diol VIIb is treated with methanesulfonyl chloride to give a mesylate, which is alkylated with a primary amine having the general  $D'-NH_2$ , wherein  $D'$  is defined as above for compounds of formula I. The resulting secondary amine is sulfonylated with a sulfonating agent having the formula  $Hal-SO_2E$ , wherein Hal is any halogen and E is defined as above for compounds of formula I, to give benzyl sulfonamide VIIc.

Sulfonamide VIIc is then hydrogenated in the presence of a suitable catalyst, such as Pd/C, to remove the benzyl group from the primary hydroxyl group

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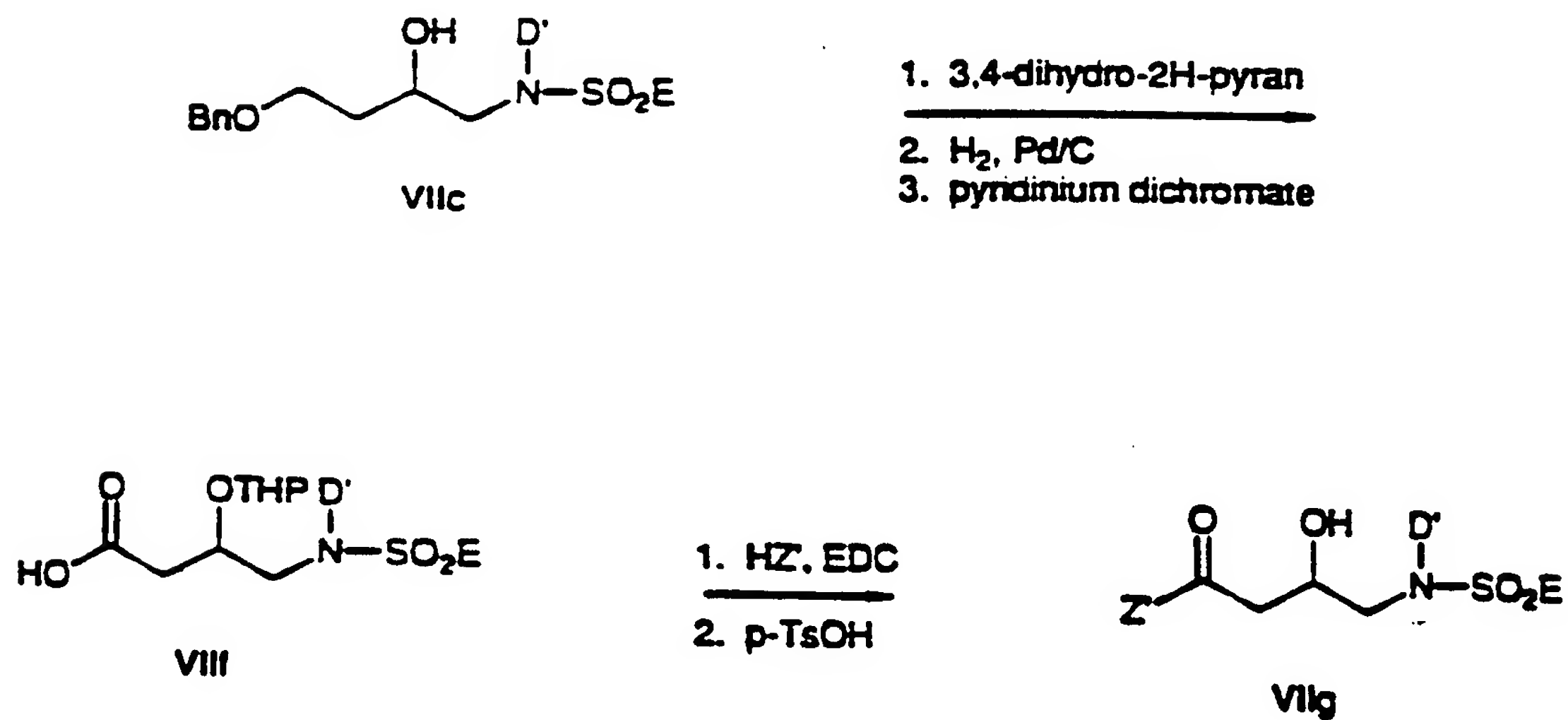
and further activated at its primary hydroxyl site to convert the primary hydroxyl to a better leaving group. Such agents useful for this purpose include, but are not limited to p-toluenesulfonyl halides, trifluoromethanesulfonyl halides, 4-bromobenzenesulfonyl halides and preferably, methanesulfonyl halides. We prefer to treat the resulting primary hydroxyl group with methanesulfonyl chloride to give mesylate VIId.

10 Mesylate VIId may then be alkylated with a primary amine having the formula D-NH<sub>2</sub>, wherein D is defined as above for compounds of formula I, to give an aminosulfonamide. The aminosulfonamide is further N-sulfonylated with a sulfonylating agent having the  
15 formula Hal-SO<sub>2</sub>E', wherein Hal is any halogen and E' is defined as E above for compounds of formula I, to give compounds of the general formula VIIe, wherein D, D' and E are defined as above for compounds of formula I and E' is defined as above.

20 Alternatively, mesylate VIId may be alkylated with an amino species HZ', wherein Z' is -N(D)SO<sub>2</sub>E, -N(H)A, -N(D)A, -N(H)E, -N(H)C(O)N(D)(E), -N(H)Het, -N(D)Het and -Het', wherein D, E, Het and A are defined  
25 above as in formula I and -Het' is a 5-10 membered nitrogen-containing heterocycle optionally substituted with any of the Het substituents mentioned for compounds of formula I. Alkylation of VIId with HZ' gives compounds of the general formula VIIa, wherein Z' is defined as above and D' and E are defined as above  
30 for compounds of formula I. The reactions described above can be utilized in an alternate order to produce compounds of formula VIIe, as shown in Scheme 4a above.

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Compounds of the present invention having the general formula VIIg are obtained by the methods described below in Scheme 5:



Scheme 5

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Sulfonamide VIIf, wherein D' and E are defined above for compounds of formula I, may be protected as its tetrahydropyran ether, using 3,4-dihydro-2H-pyran and p-toluenesulfonic acid. The resulting tetrahydropyran ether is hydrogenated in the presence of Pd/C to remove the benzyl group and give a primary alcohol. The resulting primary alcohol is then oxidized in the presence of pyridinium dichromate to give carboxylic acid VIIIf.

Carboxylic acid VIIIf may then be amidated in the presence of EDC and HOBT with an amino species HZ', wherein Z' is -N(D)SO<sub>2</sub>E, -N(H)A, -N(D)A, -N(H)E, -N(H)C(O)N(D)(E), -N(H)Het, -N(D)Het or -Het', wherein D, E, Het and A are defined above as in formula I and -Het' is a 5-10 membered nitrogen-containing heterocycle optionally substituted with any of the Het substituents mentioned for compounds of formula I. Amidation of VIIIf with HZ' gives compounds of the general formula VIIIg, wherein Z' is defined as above and D' and E are defined as above for compounds of formula I.

As can be appreciated by the skilled artisan, the above synthetic schemes are not intended to comprise a comprehensive list of all means by which the compounds described and claimed in this application may be synthesized. Further methods will be evident to those of ordinary skill in the art.

It should be understood that the compounds of this invention may be modified by appending appropriate functionalities to enhance selective biological properties. Such modifications are known in the art and include those which increase biological penetration into a given biological compartment (e.g., blood, lymphatic system, central nervous system), increase oral availability, increase solubility to allow

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administration by injection, alter metabolism and alter rate of excretion.

5 The compounds of this invention are characterized by a superior ability to inhibit protease activity and viral replication. These compounds are especially well suited for inhibiting HIV aspartyl protease. We believe that this activity is due to specific steric and electronic interactions between the protease and compounds of this invention. This belief  
10 stems from our analysis of the structural basis for the activity of compounds of this invention, in view of the known crystal structures of HIV protease and bound inhibitors, such as the structure reported in Miller et al. "Structure of Complex of Synthetic HIV-1 Protease with a Substrate-Based Inhibitor at 2.3 Å Resolution",  
15 Science, vol. 246, pp. 1149-1152 (1989), which is incorporated herein by reference, as well as structures determined in our laboratories.

20 The novel compounds of the present invention are excellent ligands for aspartyl proteases, particularly HIV-1 and HIV-2 proteases. Accordingly, these compounds are capable of targeting and inhibiting late stage events in HIV replication, i.e., the processing of the viral polyproteins by HIV encoded  
25 proteases. Such compounds inhibit the proteolytic processing of viral polyprotein precursors by inhibiting aspartyl protease. Because aspartyl protease is essential for the production of mature virions, inhibition of that processing effectively  
30 blocks the spread of virus by inhibiting the production of infectious virions, particularly from chronically infected cells. Compounds according to this invention advantageously inhibit the ability of the HIV-1 virus to infect immortalized human T cells over a period of  
35 days, as determined by an assay of extracellular p24

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antigen -- a specific marker of viral replication. Other anti-viral assays have confirmed the potency of these compounds.

5 The compounds of this invention may be used in the manufacture of a medicament for treating viral infection in a mammal. It will be evident to one skilled in the art that the compounds of this invention, including the preferred compounds of formulas VI, VII, and C, may be employed in a  
10 conventional manner for the treatment of viral infections, such as HIV and HTLV, which depend on aspartyl proteases for obligatory events in their life cycle. Such methods of treatment, their dosage levels and requirements may be selected by those of ordinary  
15 skill in the art from available methods and techniques. For example, a compound of this invention may be combined with a pharmaceutically acceptable adjuvant for administration to a virally-infected patient in a pharmaceutically acceptable manner and in an amount  
20 effective to lessen the severity of the viral infection or to alleviate pathological effects associated with HIV infection or immunosuppression such as opportunistic infections or various cancers.

25 Alternatively, the compounds of this invention may be used in used in the manufacture of a medicament for preventing viral infection in a mammal. It will be evident to one skilled in the art that the compounds of this invention, including the preferred compounds of formulas VI, VII, and C, may be used in  
30 prophylactics and methods for protecting individuals against viral infection during a specific event, such as childbirth, or over an extended period of time. The compounds may be employed in such prophylactics either alone or together with other antiretroviral agents to  
35 enhance the efficacy of each agent. As such, the novel

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protease inhibitors of this invention can be administered as agents for treating or preventing HIV infection in a mammal.

5 The compounds of this invention, especially those having a molecular weight of less than about 700 g/mole, may be readily absorbed into the bloodstream of mammals upon oral administration. Compounds of this invention having a molecular weight of less than about 600 g/mole and aqueous solubility of greater than or  
10 equal to 0.1 mg/mL are most likely to demonstrate high and consistent oral availability. This surprisingly impressive oral availability makes such compounds excellent agents for orally-administered treatment and prevention regimens against HIV infection.

15 In addition to being orally bioavailable, the compounds of this invention also have an impressively high therapeutic index (which measures toxicity versus anti-viral effect). Accordingly, the compounds of this invention are effective at lower dosage levels than  
20 many previously described conventional antiretroviral agents and avoid many of the severe toxic effects associated with those drugs. The potential of these compounds to be delivered at doses far exceeding their effective antiviral levels is advantageous in slowing  
25 or preventing the possibility of resistant variants developing.

The compounds of this invention may be administered to a healthy or HIV-infected patient either as a single agent or in combination with other  
30 anti-viral agents which interfere with the replication cycle of HIV. By administering the compounds of this invention with other anti-viral agents which target different events in the viral life cycle, the therapeutic effect of these compounds is potentiated.  
35 For instance, the co-administered anti-viral agent can

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be one which targets early events in the life cycle of the virus, such as cell entry, reverse transcription and viral DNA integration into cellular DNA. Anti-HIV agents targeting such early life cycle events include, 5 didanosine (ddI), dideoxycytidine (ddC), d4T, zidovudine (AZT), 3TC, 935U83, 1592U89, 524W91, polysulfated polysaccharides, sT4 (soluble CD4), ganiclovir, trisodium phosphonoformate, eflornithine, ribavirin, acyclovir, alpha interferon and tri- 10 menotrexate. Additionally, non-nucleoside inhibitors of reverse transcriptase, such as TIBO, delavirdine (U90) or nevirapine, may be used to potentiate the effect of the compounds of this invention, as may viral uncoating inhibitors, inhibitors of trans-activating 15 proteins such as tat or rev, or inhibitors of the viral integrase.

Combination therapies according to this invention exert an additive or synergistic effect in inhibiting HIV replication because each component agent 20 of the combination acts on a different site of HIV replication. The use of such combination therapies may also advantageously reduce the dosage of a given conventional anti-retroviral agent which would be required for a desired therapeutic or prophylactic 25 effect, as compared to when that agent is administered as a monotherapy. Such combinations may reduce or eliminate the side effects of conventional single anti-retroviral agent therapies, while not interfering with the anti-retroviral activity of those agents. These 30 combinations reduce potential of resistance to single agent therapies, while minimizing any associated toxicity. These combinations may also increase the efficacy of the conventional agent without increasing the associated toxicity. In particular, we have 35 discovered that in combination with other anti-HIV

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agents, the compounds of this invention act in an additive or synergistical manner in preventing the replication of HIV in human T cells. Preferred combination therapies include the administration of a  
5 compound of this invention with AZT, ddI, ddC, d4T, 3TC, 935U83, 1592U89, 524W91 or a combination thereof.

Alternatively, the compounds of this invention may also be co-administered with other HIV protease inhibitors such as saquinavir (Ro 31-8959, Roche), L-735,524 (Merck), ABT 538 (A-80538, Abbott),  
10 AG 1341 (Agouron), XM 412 (DuPont Merck), XM 450 (DuPont Merck), BMS 186318 (Bristol-Meyers Squibb) and CPG 53,437 (Ciba Geigy) or prodrugs of these or related compounds to increase the effect of therapy or  
15 prophylaxis against various viral mutants or members of HIV quasi species.

We prefer administering the compounds of this invention as single agents or in combination with retroviral reverse transcriptase inhibitors, such as  
20 nucleoside derivatives, or other HIV aspartyl protease inhibitors, including multiple combinations comprising from 3-5 agents. We believe that the co-administration of the compounds of this invention with retroviral reverse transcriptase inhibitors or HIV aspartyl  
25 protease inhibitors may exert a substantial additive or synergistic effect, thereby preventing, substantially reducing, or completely eliminating viral replication or infection or both, and symptoms associated therewith.

30 The compounds of this invention can also be administered in combination with immunomodulators and immunostimulators (e.g., bropirimine, anti-human alpha interferon antibody, IL-2, GM-CSF, interferon alpha, diethyldithiocarbamate, tumor necrosis factor,  
35 naltrexone, tuscarasol, and rEPO); and antibiotics

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(e.g., pentamidine isethiorate) to prevent or combat infection and disease associated with HIV infections, such as AIDS, ARC and HIV-associated cancers.

5 When the compounds of this invention are administered in combination therapies with other agents, they may be administered sequentially or concurrently to the patient. Alternatively, pharmaceutical compositions according to this invention may comprise a combination of an aspartyl protease  
10 inhibitor of this invention and one or more therapeutic or prophylactic agents.

Although this invention focuses on the use of the compounds disclosed herein for preventing and treating HIV infection, the compounds of this invention  
15 can also be used as inhibitory agents for other viruses which depend on similar aspartyl proteases for obligatory events in their life cycle. These viruses include other AIDS-like diseases caused by retroviruses, such as simian immunodeficiency viruses, HTLV-I and HTLV-II. In addition, the compounds of this  
20 invention may also be used to inhibit other aspartyl proteases, and in particular, other human aspartyl proteases, including renin and aspartyl proteases that process endothelin precursors.

25 Pharmaceutical compositions of this invention comprise any of the compounds of the present invention, and pharmaceutically acceptable salts thereof, with any pharmaceutically acceptable carrier, adjuvant or vehicle. Pharmaceutically acceptable carriers,  
30 adjuvants and vehicles that may be used in the pharmaceutical compositions of this invention include, but are not limited to, ion exchangers, alumina, aluminum stearate, lecithin, self-emulsifying drug delivery systems (SED DS) such as  $\alpha$ -tocopherol  
35 polyethyleneglycol 1000 succinate, serum proteins, such

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as human serum albumin, buffer substances such as phosphates, glycine, sorbic acid, potassium sorbate, partial glyceride mixtures of saturated vegetable fatty acids, water, salts or electrolytes, such as protamine sulfate, disodium hydrogen phosphate, potassium hydrogen phosphate, sodium chloride, zinc salts, colloidal silica, magnesium trisilicate, polyvinyl pyrrolidone, cellulose-based substances, polyethylene glycol, sodium carboxymethylcellulose, polyacrylates, waxes, polyethylene-polyoxypropylene-block polymers, polyethylene glycol and wool fat. Cyclodextrins such as  $\alpha$ -,  $\beta$ -, and  $\gamma$ -cyclodextrin, or chemically modified derivatives such as hydroxyalkylcyclodextrins, including 2- and 3-hydroxypropyl- $\beta$ -cyclodextrins, or other solublized derivatives may also be advantageously used to enhance delivery of compounds of formula I or II.

The pharmaceutical compositions of this invention may be administered orally, parenterally, by inhalation spray, topically, rectally, nasally, buccally, vaginally or via an implanted reservoir. We prefer oral administration or administration by injection. The pharmaceutical compositions of this invention may contain any conventional non-toxic pharmaceutically-acceptable carriers, adjuvants or vehicles. In some cases, the pH of the formulation may be adjusted with pharmaceutically acceptable acids, bases or buffers to enhance the stability of the formulated compound or its delivery form. The term parenteral as used herein includes subcutaneous, intracutaneous, intravenous, intramuscular, intra-articular, intrasynovial, intrasternal, intrathecal, intralesional and intracranial injection or infusion techniques.

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The pharmaceutical compositions may be in the form of a sterile injectable preparation, for example, as a sterile injectable aqueous or oleaginous suspension. This suspension may be formulated according to techniques known in the art using suitable dispersing or wetting agents (such as, for example, Tween 80) and suspending agents. The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for example, as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may be employed are mannitol, water, Ringer's solution and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose, any bland fixed oil may be employed including synthetic mono- or diglycerides. Fatty acids, such as oleic acid and its glyceride derivatives are useful in the preparation of injectables, as are natural pharmaceutically-acceptable oils, such as olive oil or castor oil, especially in their polyoxyethylated versions. These oil solutions or suspensions may also contain a long-chain alcohol diluent or dispersant such as Ph. Helv or a similar alcohol.

The pharmaceutical compositions of this invention may be orally administered in any orally acceptable dosage form including, but not limited to, capsules, tablets, and aqueous suspensions and solutions. In the case of tablets for oral use, carriers which are commonly used include lactose and corn starch. Lubricating agents, such as magnesium stearate, are also typically added. For oral administration in a capsule form, useful diluents include lactose and dried corn starch. When aqueous

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suspensions are administered orally, the active ingredient is combined with emulsifying and suspending agents. If desired, certain sweetening and/or flavoring and/or coloring agents may be added.

5           The pharmaceutical compositions of this invention may also be administered in the form of suppositories for rectal administration. These compositions can be prepared by mixing a compound of this invention with a suitable non-irritating excipient  
10       which is solid at room temperature but liquid at the rectal temperature and therefore will melt in the rectum to release the active components. Such materials include, but are not limited to, cocoa butter, beeswax and polyethylene glycols.

15           Topical administration of the pharmaceutical compositions of this invention is especially useful when the desired treatment involves areas or organs readily accessible by topical application. For application topically to the skin, the pharmaceutical  
20       composition should be formulated with a suitable ointment containing the active components suspended or dissolved in a carrier. Carriers for topical administration of the compounds of this invention include, but are not limited to, mineral oil, liquid  
25       petroleum, white petroleum, propylene glycol, polyoxyethylene polyoxypropylene compound, emulsifying wax and water. Alternatively, the pharmaceutical composition can be formulated with a suitable lotion or cream containing the active compound suspended or dissolved  
30       in a carrier. Suitable carriers include, but are not limited to, mineral oil, sorbitan monostearate, polysorbate 60, cetyl esters wax, cetearyl alcohol, 2-octyldodecanol, benzyl alcohol and water. The pharmaceutical compositions of this invention may also  
35       be topically applied to the lower intestinal tract by

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rectal suppository formulation or in a suitable enema formulation. Topically-transdermal patches are also included in this invention.

5 The pharmaceutical compositions of this invention may be administered by nasal aerosol or inhalation. Such compositions are prepared according to techniques well-known in the art of pharmaceutical formulation and may be prepared as solutions in saline, employing benzyl alcohol or other suitable  
10 preservatives, absorption promoters to enhance bioavailability, fluorocarbons, and/or other solubilizing or dispersing agents known in the art.

Dosage levels of between about 0.01 and about 100 mg/kg body weight per day, preferably between about  
15 0.5 and about 75 mg/kg body weight per day of the active ingredient compound are useful in the prevention and treatment of viral infection, including HIV infection. Typically, the pharmaceutical compositions of this invention will be administered from about 1 to  
20 about 5 times per day or alternatively, as a continuous infusion. Such administration can be used as a chronic or acute therapy. The amount of active ingredient that may be combined with the carrier materials to produce a single dosage form will vary depending upon the host  
25 treated and the particular mode of administration. A typical preparation will contain from about 5% to about 95% active compound (w/w). Preferably, such preparations contain from about 20% to about 80% active compound.

30 Upon improvement of a patient's condition, a maintenance dose of a compound, composition or combination of this invention may be administered, if necessary. Subsequently, the dosage or frequency of administration, or both, may be reduced, as a function  
35 of the symptoms, to a level at which the improved

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condition is retained when the symptoms have been alleviated to the desired level, treatment should cease. Patients may, however, require intermittent treatment on a long-term basis upon any recurrence of disease symptoms.

As the skilled artisan will appreciate, lower or higher doses than those recited above may be required. Specific dosage and treatment regimens for any particular patient will depend upon a variety of factors, including the activity of the specific compound employed, the age, body weight, general health status, sex, diet, time of administration, rate of excretion, drug combination, the severity and course of the infection, the patient's disposition to the infection and the judgment of the treating physician.

The compounds of this invention are also useful as commercial reagents which effectively bind to aspartyl proteases, particularly HIV aspartyl protease. As commercial reagents, the compounds of this invention, and their derivatives, may be used to block proteolysis of a target peptide or may be derivatized to bind to a stable resin as a tethered substrate for affinity chromatography applications. For example, a compound of formula I or II may be tethered to an affinity column to purify recombinantly produced HIV protease. Derivatization of the compounds of this invention to produce affinity chromatography resins and the methods used to purify proteases using such resins are well known and within the skill of the art. These and other uses which characterize commercial aspartyl protease inhibitors will be evident to those of ordinary skill in the art. (See: Rittenhouse, J. et al. Biochem. Biophys. Res. Commun. 171, p. 60 (1990) and Heimbach, J.C. et al. Ibid 164, p. 955 (1989)).

In order that this invention be more fully understood, the following examples are set forth.

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These examples are for the purpose of illustration only and are not to be construed as limiting the scope of the invention in any way.

#### General Materials and Methods

5 All temperatures are recorded in degrees Celsius. Thin layer chromatography (TLC) was carried out using 0.25 mm thick E. Merck silica gel 60 F<sub>254</sub> plates and elution with the indicated solvent system. Detection of the compounds was carried out by treating  
10 the plate with an appropriate visualizing agent, such as 10% solution of phosphomolybdic acid in ethanol or a 0.1% solution of ninhydrin in ethanol, followed by heating, and/or by exposure to UV light or iodine vapors when appropriate. Thick layer silica gel  
15 chromatography was also carried out using E. Merck 60 F<sub>254</sub> plates ("prep plates") of 0.5, 1.0, or 2.0 mm thickness. Following development of the plate, the band of silica containing the desired compound was isolated and eluted with an appropriate solvent.  
20 Analytical HPLC was carried out using a Water's Delta Pak, 5  $\mu$ M silica, C18 reversed-phase column, 3.9 mm ID x 15 cm L with a flow rate of 1.5 mL/min using the following table:

	Mobile phase:	A = 0.1% CF <sub>3</sub> CO <sub>2</sub> H in H <sub>2</sub> O
25		B = 0.1% CF <sub>3</sub> CO <sub>2</sub> H in CH <sub>3</sub> CN
	Gradient:	T = 0 min., A (95%), B (5%)
		T = 20 min., A (0%), B (100%)
		T = 22.5 min., A (0%), B (100%)

Preparative HPLC was also carried out using C<sub>18</sub>  
30 reversed-phase media. HPLC retention times were recorded in minutes. NMR spectral data was recorded using a Bruker AMX500, equipped with either a reverse

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or QNP probe, at 500 MHz, and was taken in the indicated solvent.

We have measured the inhibition constants of each compound against HIV-1 protease using the method described essentially by M.W. Pennington et al.,  
5 Peptides 1990, Gimet, E. and D. Andrew, Eds., Escom; Leiden, Netherlands (1990).

Compounds of invention were tested for their antiviral potency in several virological assays. In  
10 the first assay, the compounds were added as a solution in dimethylsulfoxide (DMSO) to a test cell culture of CCRM-CEM cells, a strain of CD4<sup>+</sup> human T-cell lymphoma cells, previously acutely infected with HIV<sub>IIIb</sub> using standard protocols (see Meek, T. D. et al., "Inhibition  
15 of HIV-1 protease in infected T-lymphocytes by synthetic peptide analogues", Nature, 343, p. 90 (1990)). Preferred compounds are those which are able to inhibit 90% of viral infectivity at a concentration of 1  $\mu$ M or less. More preferred compounds are those  
20 which are able to inhibit 90% of viral infectivity at a concentration of 100 nM or less.

The effect of the compounds on inhibiting the replication of the virus was measured by determining the HIV extracellular p24 antigen concentration using a  
25 commercial enzyme immunoassay (obtained from Coulter Corporation, Hialeah, FL).

Depending on the cell type and the desired readout, syncytia formation, reverse-transcriptase (RT) activity, or cytopathic effect as assayed by a dye  
30 uptake method may also be used as readouts of antiviral activity. See H. Mitsuya and S. Broder, "Inhibition of the in vitro infectivity and cytopathic effect of human T-lymphotropic virus type III/lymphadenopathy-associated virus (HTLV-III/LAV) by 2',3'-  
35 dideoxynucleosides", Proc. Natl. Acad. Sci. USA,

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10

15

### Example 1

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overnight. The reaction mixture was diluted with 300 mL of diethyl ether and washed with water (three times) and brine. The ether solution was dried ( $\text{MgSO}_4$ ), filtered and concentrated in vacuo to give to give  
5 0.774 g of Compound 1B as a colorless, viscous oil. TLC:  $R_f = 0.61$ , 5% diethyl ether/methylene chloride.  $^1\text{H}$  NMR consistent with structure.

C. Compound 1C. 0.213 g of the resultant compound of Example 1B, 0.351 g of benzylamine and 3 mL of MeOH  
10 were heated overnight in a sealed tube at  $100^\circ\text{C}$ . The reaction mixture was concentrated in vacuo, purified by silica gel chromatography (10% MeOH/methylene chloride) to remove the remaining benzylamine and repurified by silica gel chromatography (8% MeOH/methylene chloride)  
15 to give 87 mg of Compound 1C. TLC:  $R_f = 0.44$ , 8% MeOH/methylene chloride.  $^1\text{H}$  NMR consistent with structure.

D. Compound XXI. To 5 mL of methylene chloride was added 21 mg of the resultant compound of Example 1C,  
20 11.1 mg of 3-(S)-tetrahydrofuranyl succinamidyl carbonate and 18.8 mg of diisopropylethylamine. The reaction mixture was diluted with 50 mL of methylene chloride and the organic layer was washed with 50 mL of 0.5N HCl, 50 mL of saturated, aqueous  $\text{NaHCO}_3$ , and 50 mL  
25 of brine. The organic layer was dried over magnesium sulfate and concentrated in vacuo to give 26.4 mg of Compound XXI as a colorless oil. TLC:  $R_f = 0.28$ , 20% diethyl ether/methylene chloride. HPLC:  $R_t = 16.33$  min.

30

Example 2

Compound XXII. To 5 mL of methylene chloride was added 29 mg of the resultant compound of Example

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1C, 7.3 mg of t-butyliisocyanate and 19.1 mg of diisopropylethylamine. After 12h, the reaction mixture was concentrated in vacuo, diluted with ethyl acetate, washed with 0.5 N HCl, washed with brine, dried (MgSO<sub>4</sub>) and reconcentrated in vacuo to afford 35.4 mg of Compound XXII as a yellow oil. TLC: R<sub>f</sub> = 0.15, 5% diethyl ether/methylene chloride; 0.58, 20% diethyl ether/methylene chloride. HPLC: R<sub>t</sub> = 17.68 min.

### Example 3

10 A. To 2 mL of MeOH was added 198 mg of the resultant compound of Example 1B and 369 mg of phenethylamine. The reaction mixture was heated for 48h and then allowed to cool to room temperature. The reaction mixture was concentrated in vacuo and passed through a silica plug (8% MeOH/methylene chloride) to afford 272 mg of Compound 3A as a yellow oil. TLC: R<sub>f</sub> = 0.48, 8% MeOH/methylene chloride. <sup>1</sup>H NMR consistent with structure.

20 B. Compound XXIV. To a mixture of 5 mL of methylene chloride and 2 mL of saturated, aqueous sodium bicarbonate was added 29 mg of the resultant compound of Example 3A, 12.6 mg of benzenesulfonyl chloride and 16 mg of sodium bicarbonate. The reaction mixture was allowed to stir at room temperature for 3h. The reaction mixture was diluted with methylene chloride and brine, and the organic layer was separated, dried (MgSO<sub>4</sub>) and concentrated in vacuo. Purification by silica gel chromatography (5% diethyl ether/methylene chloride) gave 25.5 mg of Compound XXIV. TLC: R<sub>f</sub> = 0.49, 5% diethyl ether/methylene chloride. HPLC: R<sub>t</sub> = 18.50 min. <sup>1</sup>H NMR was consistent with structure.

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Example 4

A. Sodium hydride (80% dispersion in oil) (0.024 g, 1.100 mmol) was added to a solution of N-cyclopentylmethyl-4-methoxybenzenesulfonamide (0.288 g, 0.847 mmol) in 10 mL of DMF at 0 °C and the mixture was stirred for 0.5 h. (2S)-Glycidyl tosylate (0.232 g, 1.016 mmol) was then added and the mixture was allowed to warm to R.T. and was stirred overnight. The mixture was quenched with MeOH (1 mL) and concentrated in vacuo. The residue was taken up in EtOAc and was washed with water (3X100 mL), dried over MgSO<sub>4</sub>, and concentrated to give a colorless oil. Purification by silica gel column chromatography (5% Et<sub>2</sub>O/CH<sub>2</sub>Cl<sub>2</sub>) gave epoxide (273 mg, 99%) as a colorless oil. <sup>1</sup>H NMR consistent with structure.

B. The epoxide prepared in Example 4A (0.093 g, 0.289 mmol) and isobutylamine (0.105 g, 1.43 mmol) in 5 mL of EtOH were heated at 100 °C in a sealed tube for 1 day. The crude material was taken up in MeOH, concentrated, then purified by silica gel column chromatography (8% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) to give the amine. <sup>1</sup>H NMR consistent with structure.

C. The procedure described in Example 1D was performed using the amine prepared in Example 4B (0.047 g, 0.118 mmol). Purification of the crude material by silica gel column chromatography (10-20% Et<sub>2</sub>O/CH<sub>2</sub>Cl<sub>2</sub>) gave Compound 1004 (43 mg, 71%). <sup>1</sup>H NMR consistent with structure.

Example 5

A. The procedure described in Example 4B was performed using the 86 mg of epoxide and 2-

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phenethylamine (0.160 g, 1.32 mmol) to give the amine (0.097 g, 82%). <sup>1</sup>H NMR consistent with structure.

5 B. The procedure described in Example 4C was performed using the amine prepared in Example 5A (0.024 g, 0.054 mmol) and 1,3-dioxan-4-yl-4-nitrophenyl carbonate (described in Example 29A) (0.018 g, 0.059 mmol) to give Compound 1005 (3.9 mg, 13%). <sup>1</sup>H NMR consistent with structure.

#### Example 6

10 A. The procedure described in Example 1A was performed using isobutylamine (0.396 g, 5.41 mmol) and 3-nitrobenzenesulfonyl chloride (1.0 g, 4.5 mmol) to give N-isobutyl-3-nitrobenzenesulfonamide (0.916 g, 78%). <sup>1</sup>H NMR consistent with structure.

15 B. The procedure described in Example 4A was performed using the sulfonamide prepared in Example 6A (0.560 g, 2.17 mmol) to give the epoxide (0.650 g, 95%). <sup>1</sup>H NMR consistent with structure.

20 C. The procedure described in Example 5A was performed using the epoxide prepared in Example 6B (0.410 g, 1.30 mmol) to give the amine (0.244 g, 43%). <sup>1</sup>H NMR consistent with structure.

25 D. The procedure described in Example 1D was performed using the amine prepared in Example 6C (0.064 g, 0.147 mmol) to give the nitro sulfonamide (0.061 g, 76%). <sup>1</sup>H NMR consistent with structure.

E. The nitrosulfonamide prepared in Example 6D (0.061 g, 0.110 mmol) and 10 wt.% palladium on carbon (10 mg)

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in 20 mL of EtOAc was stirred overnight under hydrogen gas. The mixture was filtered, concentrated and chromatographed on a silica gel column (3% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) to give Compound 1012 (0.049 g, 85%). <sup>1</sup>H NMR  
5 consistent with structure.

#### Example 7

A. The procedure described in Example 1A was performed using cyclopentylmethylamine (0.482 g, 4.86 mmol) and 3-nitrobenzenesulfonyl chloride (1.077 g, 4.86 mmol) to give the amine (1.29 g, 93%). <sup>1</sup>H NMR  
10 consistent with structure.

B. The procedure described in Example 4A was performed using the amine prepared in Example 7A (0.727 g, 2.56 mmol) to give the epoxide (1.20 g, crude material). <sup>1</sup>H NMR consistent with structure.  
15

C. The procedure described in Example 5A was performed using the epoxide prepared in Example 7B (0.216 g, 0.635 mmol) to give the amine (0.142 g, 48%). <sup>1</sup>H NMR consistent with structure.

D. The procedure described in Example 1D was performed using the amine prepared in Example 7C (0.034 g, 0.074 mmol) and 4-nitrophenyl-tetrahydrofurodihydrofuran-3-yl carbonate (0.033 g, 0.110 mmol) to give the nitro sulfonamide (0.025 g, 55%). <sup>1</sup>H NMR consistent with structure.  
20  
25

E. The procedure described in Example 6E was performed using the nitro sulfonamide prepared in Example 7D (0.019 g, 0.031 mmol) to give Compound 1013 (0.011 g, 26%). <sup>1</sup>H NMR consistent with structure.

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Example 8

5 A. The procedure described in Example 5B was performed using the amine prepared in Example 7C (0.039 g, 0.085 mmol) to give the nitro sulfonamide (0.025 g, 50%). <sup>1</sup>H NMR consistent with structure.

B. The procedure described in Example 6E was performed using the nitro sulfonamide prepared in Example 8A (0.025 g, 0.042 mmol) to give Compound 1014 (0.020 g, 86%). <sup>1</sup>H NMR consistent with structure.

10

Example 9

15 A. The procedure described in Example 4B was performed using 226 mg of the epoxide and 3,4-dibenzzyloxyphenethylamine hydrochloride (1.28 g, 3.47 mmol) to give the amine (0.200 g, 44%). <sup>1</sup>H NMR consistent with structure.

20 B. The procedure described in Example 1D was performed using the amine prepared in Example 9A (0.076 g, 0.115 mmol) to give the dibenzyl protected sulfonamide (0.057 g, 64%). <sup>1</sup>H NMR consistent with structure.

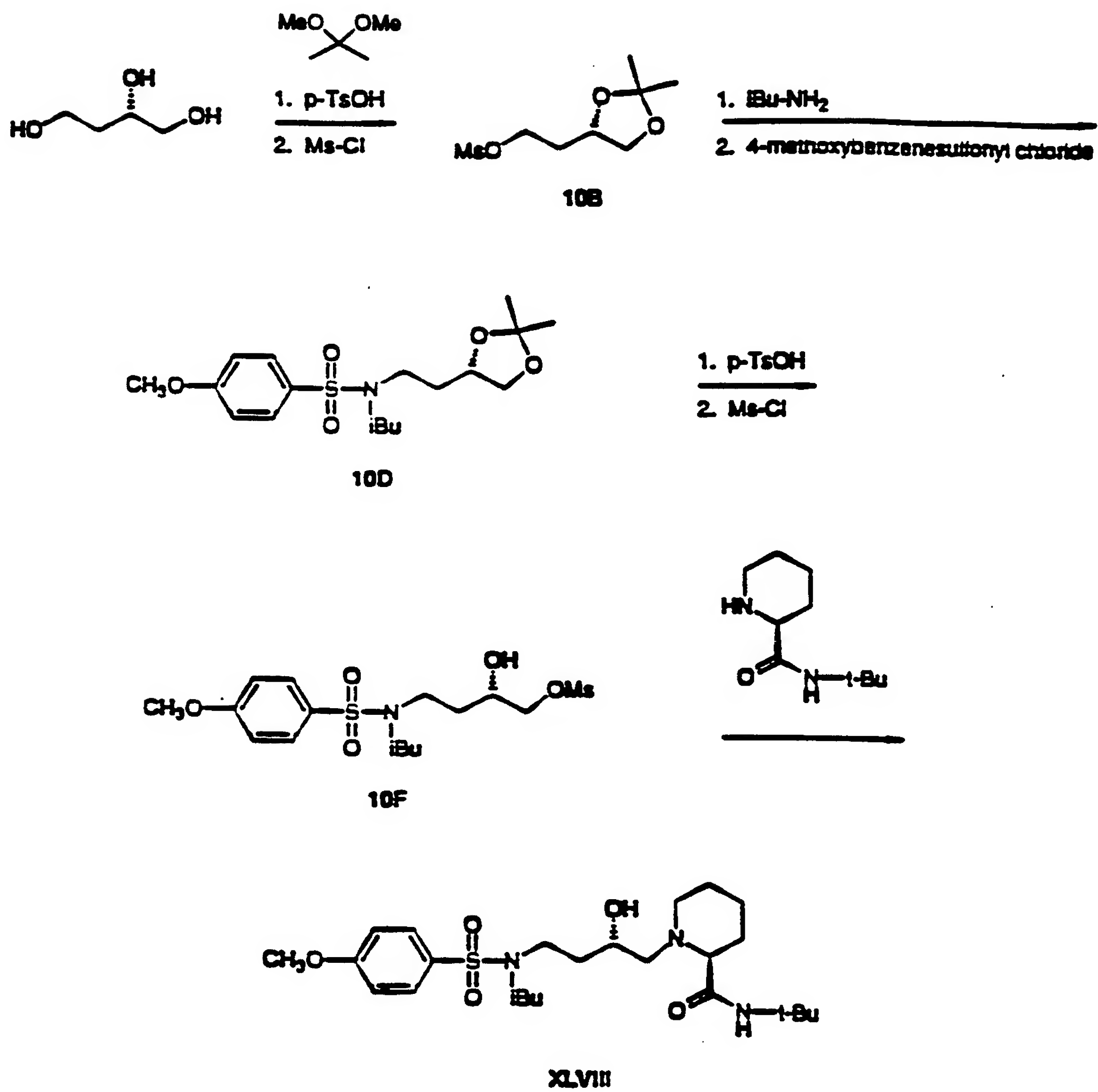
25 C. The dibenzyl protected sulfonamide (0.057 g, 0.074 mmol) was dissolved in EtOAc whereupon a slurry of 10 wt.% palladium on carbon in EtOAc was added. The mixture was stirred overnight at R.T. under an atmosphere of H<sub>2</sub>. The crude material was purified by prep TLC (2 plates, 0.5 mm SiO<sub>2</sub>, 3% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) to give Compound 1017 (0.021 g, 61%). <sup>1</sup>H NMR consistent with structure.

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Example 10

Compound XLVIII is synthesized according to Scheme 10:

- 146 -



Scheme 10

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- 5      A.    Compound 10A. To a solution of 3 mL of (S)-1,2,4-butanetriol and 4.1 mL of 2,2-dimethoxypropane in 10 mL of toluene was added 2 mg of p-toluenesulfonic acid. The reaction mixture was heated at 70°C for 3h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate, washed with brine and dried over magnesium sulfate. Concentration in vacuo gave 3.54 g of Compound 10A. <sup>1</sup>H NMR consistent with structure.
- 10      B.    Compound 10B. To a solution of 269.4 mg of the resultant compound of Example 10A in 2 mL of methylene chloride was added 0.35 mL of diisopropylethylamine. The reaction mixture was cooled to -20°C, and to it was added 0.16 mL of methanesulfonyl chloride. The  
15      reaction mixture was allowed to warm to room temperature for 0.5h. The reaction mixture was diluted with 40 mL of methylene chloride and washed with water and brine. The methylene chloride layer was dried (MgSO<sub>4</sub>), filtered and concentrated in vacuo to give  
20      434.6 mg of Compound 10B as a colorless oil.
- 25      C.    Compound 10C. A mixture of 154.2 mg of the resultant compound of Example 10B and 1 mL of isobutylamine was allowed to stir at room temperature overnight. After heating at 50°C for 0.5h, the  
25      reaction mixture was concentrated in vacuo to afford 138.4 mg of Compound 10C as a semi-solid. <sup>1</sup>H NMR consistent with structure.
- 30      D.    Compound 10D. To a mixture of 136.8 mg of the resultant compound of Example 10C in 2 mL of methylene chloride and 1 mL of saturated, aqueous sodium bicarbonate was added solid sodium bicarbonate, followed by 210.6 mg of 4-methoxybenzenesulfonyl

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- chloride. The reaction mixture was allowed to stir at room temperature for 0.5h. The reaction mixture was diluted with methylene chloride and washed with water and brine. The methylene chloride layer was dried over magnesium sulfate and concentrated in vacuo to give 277.4 mg of an almost equimolar mixture of Compound 10D and N-iso-butyl-4-methoxybenzenesulfonamide. TLC:  $R_f$  = 0.41, 4:1 hexane/ethyl acetate.  $^1\text{H}$  NMR consistent with structure.
- 10 E. Compound 10E. To a solution of 254.4 mg of the resultant mixture of Example 10D in 2 mL of MeOH was added p-toluenesulfonic acid. The reaction mixture was allowed to stir at room temperature until TLC indicated that most of the starting material was consumed. The reaction mixture was concentrated in vacuo and purified by silica gel chromatography (100% methylene chloride, followed by 50% methylene chloride/ethyl acetate then 100% ethyl acetate) to give 142.4 mg of Compound 10E. TLC:  $R_f$  = 0.24, 1:1 methylene chloride/ethyl acetate.
- 20 F. Compound 10F. To a solution of 142.4 mg of the resultant compound of Example 10E in 1 mL of methylene chloride was added 44.7 mmol of methanesulfonyl chloride followed by 1 mL of diisopropylethylamine at  $-60^\circ\text{C}$ . The reaction was allowed to stir at  $-60^\circ\text{C}$  for 10 minutes and to warm to room temperature over 0.5h. After stirring overnight at room temperature, the reaction mixture was diluted with ethyl acetate and washed with water and brine. The ethyl acetate layer was dried ( $\text{MgSO}_4$ ), filtered, concentrated in vacuo and purified by silica gel chromatography (4:1 methylene chloride/ethyl acetate) to give 126.0 mg of Compound 10F.  $^1\text{H}$  NMR consistent with structure.

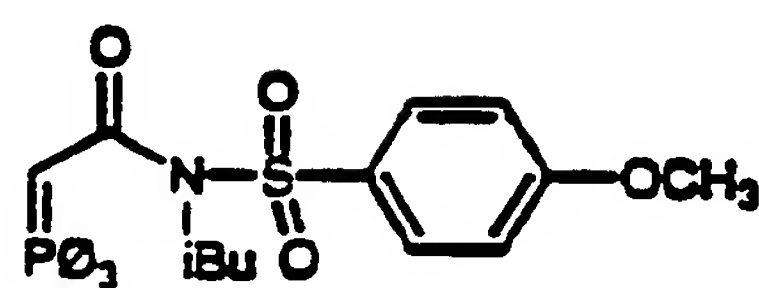
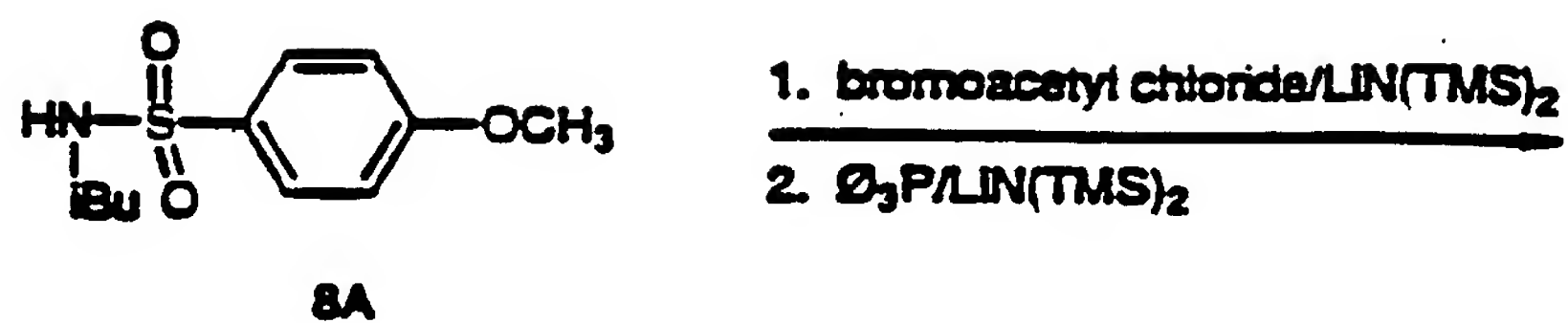
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G. Compound XLVIII. A mixture of 126.0 mg of the resultant compound of Example 10F, 68.0 mg of N-t-butyl-L-pipecolinamide and 106 mg of potassium carbonate in 1.5 mL of isopropanol was heated at 80-85°C overnight. After cooling to room temperature, the reaction mixture was concentrated in vacuo and purified by silica gel chromatography (3:2 methylene chloride/ethyl acetate) to give 113.7 mg of Compound XLVIII. TLC: Rf = 0.37, 100% ethyl acetate. HPLC: Rt = 13.06 min.

#### Example 11

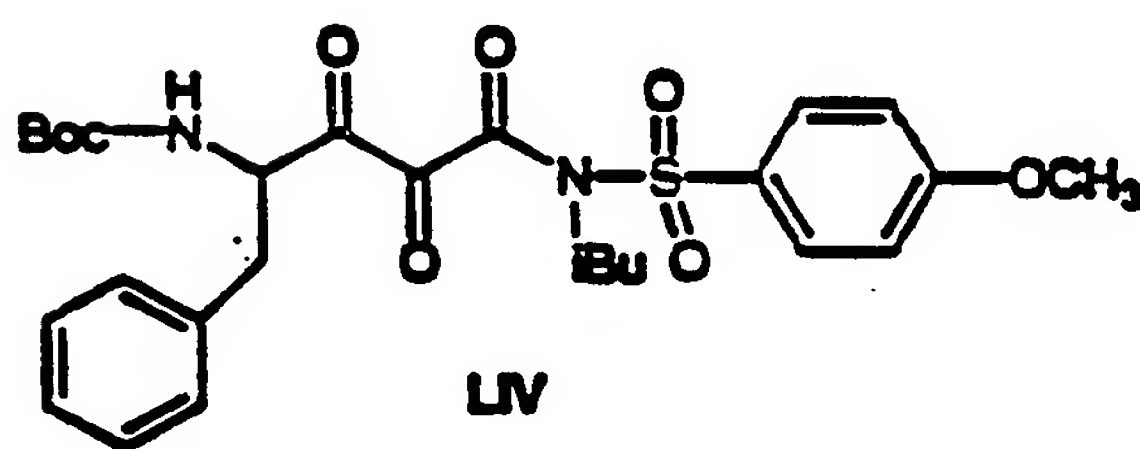
Compound LIV is synthesized according to the following scheme:

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11B

1. Boc-L-phenylalanine  
EDC / DMAP  
2. Oxone<sup>®</sup>



Scheme 11

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Starting Compound 8A. To a solution of 1.38 g of iso-butylamine in methylene chloride was added 3.17 g of sodium bicarbonate, saturated sodium bicarbonate solution and 3.90 g of 4-methoxybenzenesulfonyl chloride. The reaction mixture was allowed to stir at room temperature overnight and diluted with ethyl acetate. The organic phase was washed with 0.5 N HCl and brine, and dried ( $\text{MgSO}_4$ ), filtered and concentrated in vacuo to give 4.72 g of Compound 8A.

10 A. Compound 11A. To a solution of 1 eq. of Compound 8A in dry THF is added 1.1 eq. of lithium bis(trimethylsilyl)amide (1M solution in THF) at 0°C. After 0.5h, the resulting solution is added dropwise to a solution of 1 eq. of bromoacetyl chloride in THF at 15 0°C. After an additional 10 min., the reaction mixture is diluted with water. The aqueous mixture is washed with ethyl acetate and combined organic fractions are washed with brine, dried ( $\text{MgSO}_4$ ) and concentrated in vacuo. The resulting residue is purified by silica gel 20 chromatography to give Compound 11A.

B. Compound 11B. To a solution of 1 eq. of the resultant compound of Example 11A in dry toluene is added 1 eq. of triphenylphosphine. The reaction is allowed to stir overnight at 60°C and gives a 25 triphenylphosphonium salt precipitate. The reaction mixture is cooled to 0°C and to it is added 1 eq. of lithium bis(trimethylsilyl)amide (1M solution in THF). The reaction mixture is diluted with water and the organic phase is dried ( $\text{MgSO}_4$ ) and concentrated in 30 vacuo. The resulting residue is purified by silica gel chromatography to give Compound 11B.

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5 C. Compound 11C. To a solution of 1 eq. of the resultant compound of Example 11B in dry toluene is added 1 eq. of Boc-L-phenylalanine, 1 eq. of dimethylaminopropylethylcarbodiimide and a catalytic amount of 4-dimethylaminopyridine. After stirring at room temperature until TLC indicates the disappearance of starting material, the reaction mixture is diluted with ethyl acetate and washed with saturated aqueous sodium bicarbonate and brine. The organic phase is  
10 dried (MgSO<sub>4</sub>) and concentrated in vacuo to give Compound 11C.

15 D. Compound LIV. To a mixture of 1 eq. of the resultant compound of Example 11C in THF/water (2:1) is added 1.5 eq. of Oxone®. The reaction mixture is stirred at room temperature until TLC indicates a disappearance of starting material. The reaction mixture is diluted with ethyl acetate and concentrated in vacuo. Purification of the resulting residue by silica gel chromatography gives Compound LIV.

20

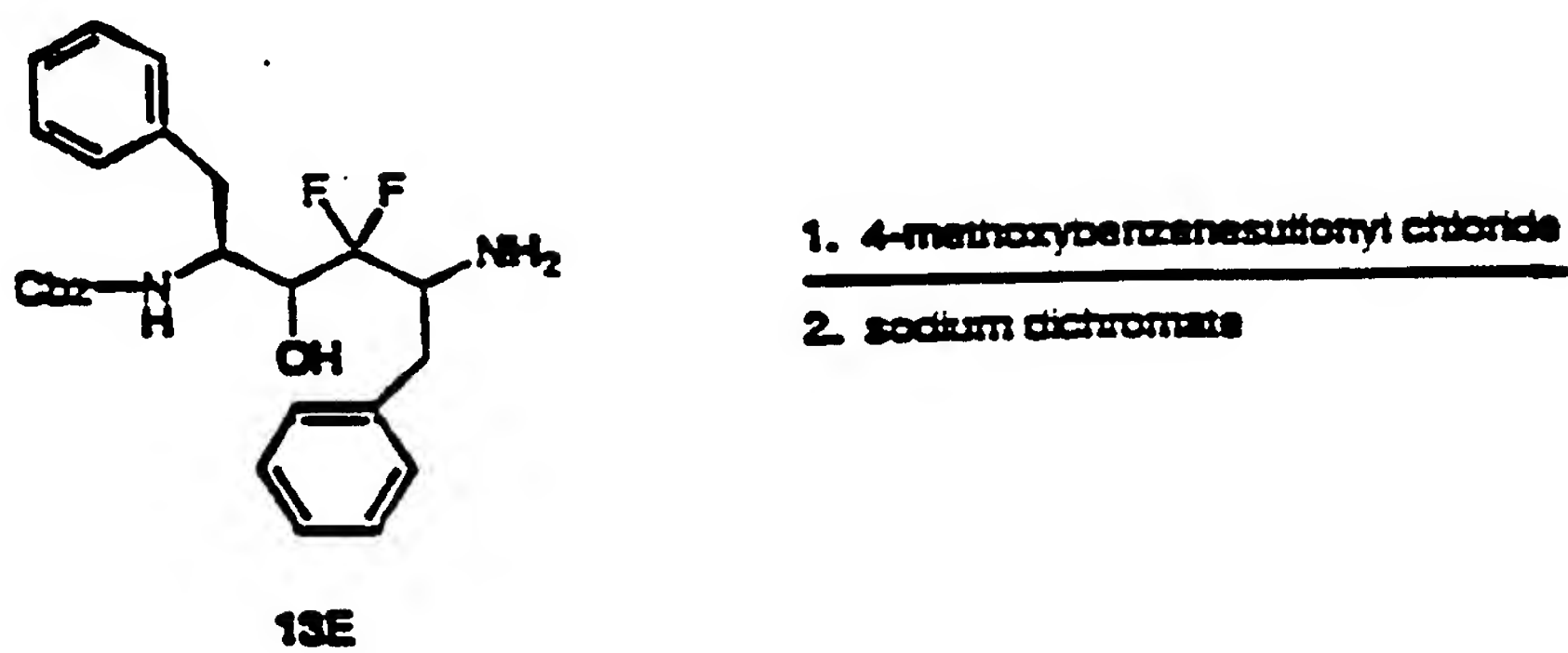
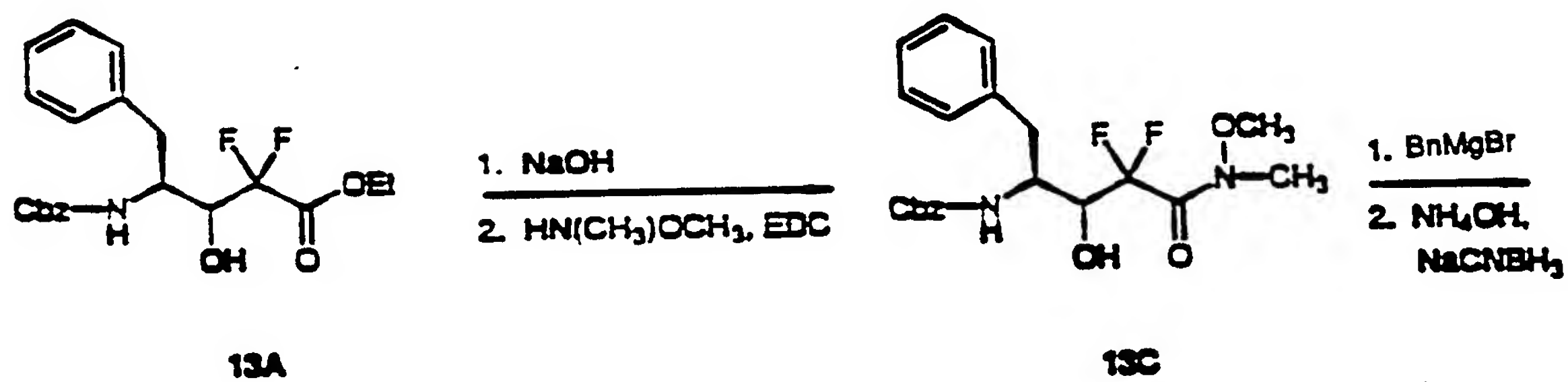
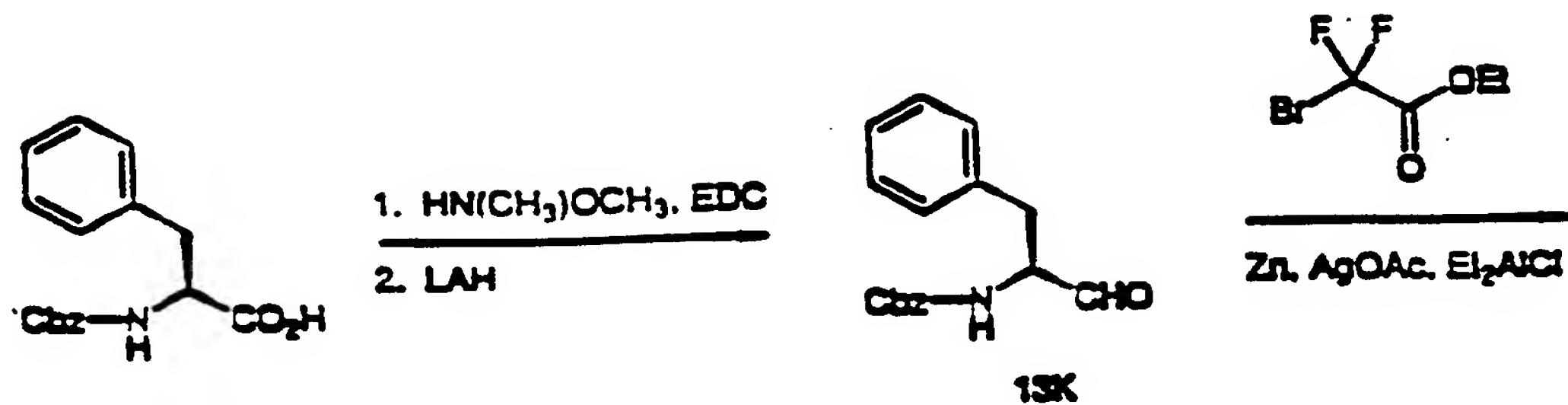
#### Example 12

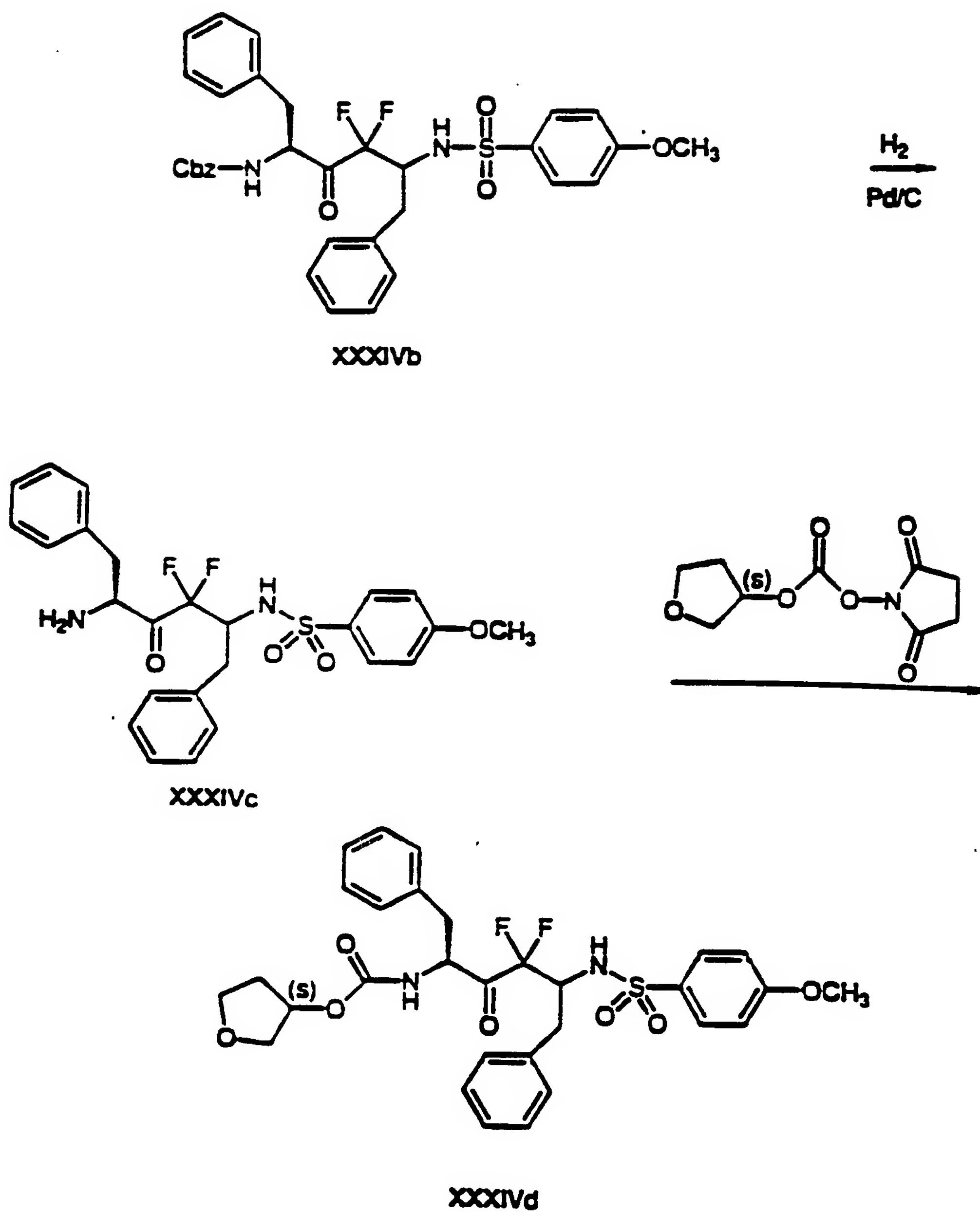
A. The procedure described in Example 1A was performed using N-(2(S)-hydroxy-4-phenethylamino)butyl-N-isobutyl-4-methoxybenzenesulfonamide (0.043 g, 0.099 mmol) to give Compound 1035. <sup>1</sup>H NMR consistent with  
25 structure. R<sub>f</sub>=0.23 (hexanes:EtOAc, 4:1).

#### Example 13

Compound XXXIV is synthesized according to scheme 13:

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Scheme 13

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5 A. Compound 13A. To a solution of 3.2 g of the resultant compound of Example 13K in 20 mL of THF cooled to 0°C was added 1.84 g of Zn, 0.57 g of AgOAc, 4.6 g of methyl bromodifluoroacetate and 11.3 mmol of diethylaluminum chloride. The reaction mixture was allowed to stir for 3h at 0°C and then overnight at room temperature. The reaction mixture was diluted with 10 mL of ethanol, 20 mL of saturated, aqueous ammonium chloride and 30 mL of saturated, aqueous  
10 potassium sodium tartrate. The resulting mixture was filtered and the filtrate was washed with 300 mL of ethyl acetate. The ethyl acetate layer was dried over magnesium sulfate, concentrated in vacuo and purified by medium pressure liquid chromatography (100%  
15 methylene chloride followed by 1% MeOH/methylene chloride) to give 3.92 g of Compound 13A.

20 B. Compound 13B. A methanolic solution of the resultant compound of Example 13A is treated with 1.1 eq. of 1N NaOH. When thin layer chromatography reveals the disappearance of starting material, the reaction mixture is diluted with water and extracted into ethyl acetate. The aqueous layer is acidified to pH 2 with 1N HCl and extracted with ethyl acetate. Concentration in vacuo gives Compound 13B.

25 C. Compound 13C. The resultant compound of Example 13B is dissolved into THF and to the resulting solution is added 1 eq. of triethylamine, 1 eq. of 1-hydroxybenzotriazole, 1 eq. of EDC and 1 eq. of methoxymethylamine. The reaction is allowed to stir at  
30 room temperature. After thin layer chromatography reveals the disappearance of starting material, the reaction mixture is diluted with ethyl acetate and washed with 1N HCl, saturated sodium bicarbonate

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solution and brine. The organic phase is dried and concentrated in vacuo to give Compound 13C.

5 D. Compound 13D. To a solution of the resultant compound of Example 13C in THF cooled to 0°C is added 3-5 eq. of benzylmagnesium chloride. After thin layer chromatography reveals the disappearance of starting material, the reaction mixture is quenched with water and extracted in ethyl acetate. Concentration in vacuo followed by purification by silica gel chromatography gives Compound 13D.

15 E. Compound 13E. To a solution of the resultant compound of Example 13D in ethanol is added excess ammonium hydroxide and excess sodium cyanoborohydride. The reaction mixture is allowed to stir at room temperature. When thin layer chromatography reveals the disappearance of starting material, the reaction mixture is quenched with water and extracted into ethyl acetate. Concentration of the organic layer in vacuo gives Compound 13E.

20 F. Compound 13F. The procedure described in Example 10D was performed using the resultant compound of Example 13E to give Compound 13F.

25 G. Compound XXXIVb. The resultant compound of Example 13F is dissolved in acetic acid and treated with 1 eq. of sodium dichromate. When thin layer chromatography reveals the disappearance of starting material, the reaction mixture is diluted with water and extracted into ethyl acetate. Concentration in vacuo followed by purification by silica gel chromatography gives Compound XXXIVb.

30

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5 H. Compound XXXIVc. To a solution of the resultant compound of Example 13G in dry ethanol is added under a hydrogen atmosphere Pd/C (10% by weight). The reaction is purged with nitrogen, filtered through Celite® and concentrated in vacuo to give Compound XXXIVc.

10 I. Compound XXXIVd. To a solution of the resultant compound of Example 13H in methylene chloride is added 1 eq. of 3-(S)-tetrahydrofuranyl succinamidyl carbonate and 1 eq. of diisopropylethylamine. After thin layer chromatography shows the disappearance of starting material, the reaction mixture is concentrated in vacuo and purified by silica gel chromatography to give Compound XXXIVd.

15 J. Compound 13J. To a solution of 20 g of Cbz-L-phenylalanine in 200 mL of dry THF under nitrogen was added 9.9 g of HOBT, 7.17 g of N-methoxy-N-methylammonium hydrochloride, 14.1 g of EDC and 13.5 g of triethylamine. The reaction mixture was allowed to stir for 60h at room temperature. The reaction mixture  
20 was diluted with 200 mL of water, extracted into 1L of diethyl ether, dried over magnesium sulfate, concentrated in vacuo and purified by medium pressure liquid chromatography (100% methylene chloride, followed by 1% MeOH/methylene chloride, then 2%  
25 MeOH/methylene chloride) to give 19.95 g of Compound 13J.

30 K. Compound 13K. To a mixture of 1.35 g of lithium aluminum hydride in 250 mL of diethyl ether cooled to -55°C was added a solution of 10.21 g of the resultant compound of Example 13J in 100 mL of diethyl ether, dropwise, maintaining the reaction temperature below -45°C. The reaction mixture was allowed to stir at

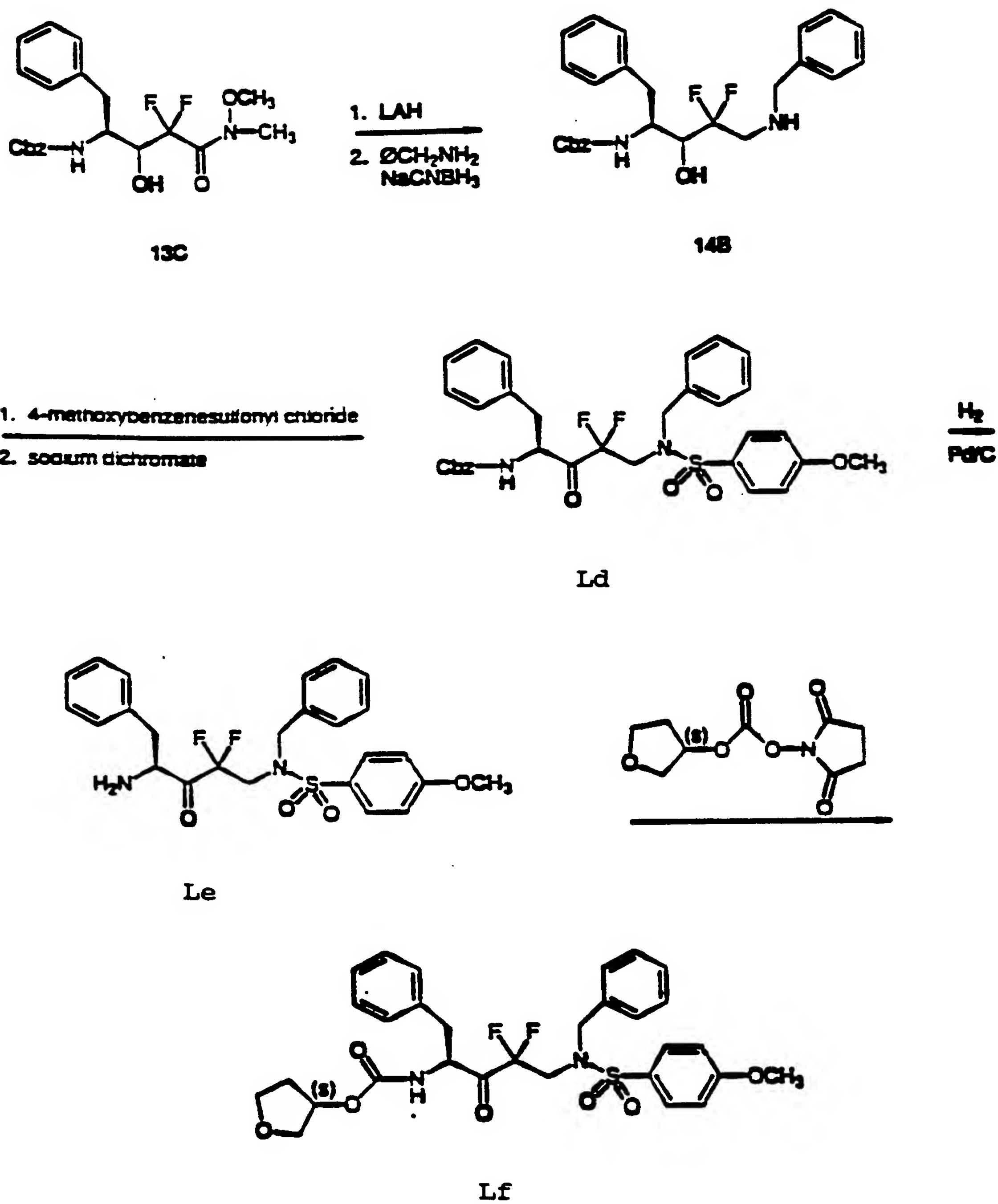
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-50°C for 3h. The reaction mixture was quenched with 200 mL of saturated potassium sodium tartrate solution and was allowed to warm to room temperature. The reaction mixture was diluted with 600 mL of diethyl ether and the organic layer was dried over magnesium sulfate, concentrated in vacuo and purified by medium pressure liquid chromatography (1% MeOH/methylene chloride) to give 5.52 g of Compound 13K.

#### Example 14

Compound Ld is synthesized according to Scheme 14:

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Scheme 14

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5 A. Compound 14A. To a solution of the resultant compound of Example 13C in THF cooled to 0°C is added 1.1 eq. of lithium aluminum hydride. The reaction mixture is quenched with water and extracted into ethyl acetate. Concentration in vacuo gives Compound 14A.

10 B. Compound 14B. The resultant compound of Example 14A is dissolved in ethanol and treated with an excess of benzylamine and sodium cyanoborohydride. The reaction mixture is worked up as in Example 13E to give Compound 14B.

C. Compound 14C. The resultant compound of Example 14B is treated and worked up as described in Example 13F to give Compound 14C.

15 D. Compound 14D. The resultant compound of Example 14C is treated and worked up as described in Example 13G to give Compound 14D.

E. Compound 14E. The resultant compound of Example 14D is treated and worked up as described in Example 13H to give Compound 14E.

20 F. Compound 14F. The resultant compound of Example 14E is treated and worked up as described in Example 13I to give Compound 14F.

#### Example 15

25 A. The procedure described in Example 5B was performed using 30 mg (0.067 mmol) of the amine and 1,3-dioxolan-4-ylmethyl-4-nitrophenyl carbonate (0.045 g, 0.168 mmol) to give Compound 1018 (0.006 g, 14%).  
'H NMR consistent with structure.

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Example 16

5 A. The procedure described in Example 27K was performed using 4-benzyloxycarbonyl-2(S)-N'-(t-butylcarboxamido)piperazine (0.035 g, 0.110 mmol) to give after prep. TLC (EtOAc/CH<sub>2</sub>Cl<sub>2</sub>, 1:1) purification Compound 1031 (0.050 g, 73% for 2 steps). <sup>1</sup>H NMR consistent with structure.

Example 17

10 A. Dimethylsulfamoyl chloride (0.022 mL, 0.20 mmol) was added to a solution of N-(2(S)-hydroxy-4-isobutylamino)butyl-N-isobutyl-4-methoxybenzenesulfonamide (0.032 g, 0.08 mmol), sat. aq. NaHCO<sub>3</sub> and solid NaHCO<sub>3</sub> in CH<sub>2</sub>Cl<sub>2</sub>. The mixture was stirred at R.T. overnight then diluted with EtOAc. The organic phase was washed with water, brine, dried over  
15 MgSO<sub>4</sub> and concentrated. Purification by prep TLC (15% EtOAc/CH<sub>2</sub>Cl<sub>2</sub>) gave Compound 1034 (0.022 g, 55%) as a colorless oil. <sup>1</sup>H NMR consistent with structure.

Example 18

20 A. A solution of benzylhydrazine dihydrochloride salt (128 mmol) in CH<sub>2</sub>Cl<sub>2</sub> was treated with di-tert-butyl dicarbonate (170 mmol) and excess of triethylamine (ca. 256 mmol) to give Compound 18A in 90% yield. <sup>1</sup>H NMR consistent with structure.

25 B. N-Cyclopentylmethyl-N-glycidyl-3-nitrophenylbenzenesulfonamide (6 mmol) (prepared utilizing the method described in Example 1A using 3-nitrobenzenesulfonyl chloride and subjecting that

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product to the method described in Example 1B) was treated with neat Compound 18A (43 mmol) at 100 °C for 24 h. The crude material was purified by silica gel column chromatography (1% MeOH/CH<sub>2</sub>Cl<sub>2</sub> to 5% MeOH/CH<sub>2</sub>Cl<sub>2</sub> to 90:10:1 CH<sub>2</sub>Cl<sub>2</sub>/MeOH/NH<sub>4</sub>OH) to give Compound 18B (1.91 g, 60%). <sup>1</sup>H NMR consistent with structure.

C. A solution of Compound 18B (0.115 g, 0.20 mmol) in CH<sub>2</sub>Cl<sub>2</sub> was treated with DIEA (0.22 mmol) and benzoyl chloride (0.22 mmol) at 0 °C followed by warming to R.T. The mixture was extracted with EtOAc and the combined extracts washed with 10% aq. HCl, sat. aq. NaHCO<sub>3</sub>, brine, dried over MgSO<sub>4</sub> and concentrated. The crude material was purified by silica gel column chromatography (25% EtOAc/hexanes) to give Compound 18C (0.078 g, 58%). <sup>1</sup>H NMR consistent with structure.

D. A solution of Compound 18C (0.060 g, 0.10 mmol) was treated with SnCl<sub>2</sub> dihydrate (0.50 mmol) in EtOH for 4h. The mixture was treated with sat. aq. NaHCO<sub>3</sub> and extracted with EtOAc. The combined washes were concentrated to give Compound 18D which was used without further purification.

E. A solution of Compound 18D in TFA (1 mL) and CH<sub>2</sub>Cl<sub>2</sub> (2 mL) was stirred 1 h at R.T. The mixture was concentrated and purified by silica gel column chromatography (hexanes/EtOAc, 1:1) to give Compound 1125 (0.030 g, 55% over 2 steps). <sup>1</sup>H NMR consistent with structure. HPLC: retention time=15.18 min.

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Example 19

5 A. The procedure described in Example 1A was performed using N-(4-cyclopentylmethylamino-2(S)-hydroxy)butyl-N-isobutyl-4-methoxybenzenesulfonamide (0.050 g, 0.121 mmol) and benzenesulfonyl chloride (0.043 g, 0.243 mmol) to give Compound 1122 (0.030 g, 45%). <sup>1</sup>H NMR consistent with structure.

Example 20

10 A. The procedure described in Example 1A was performed using N-(4-cyclopentylmethylamino-2(S)-hydroxy)butyl-N-isobutyl-4-methoxybenzenesulfonamide (0.050 g, 0.121 mmol) and 4-benzyloxybenzenesulfonyl chloride (0.069 g, 0.244 mmol) to give Compound 20A (0.047 g, 59%). <sup>1</sup>H NMR consistent with structure.

15 B. The procedure described in Example 6E was performed using Compound 20A (0.045 g, 0.068 mmol) to give Compound 1123 (0.035 g, 90%). <sup>1</sup>H NMR consistent with structure.

Example 21

20 A. Compound 21A. The resultant compound of Example 27G was treated with isobutylamine in a manner identical to that described in Example 30D to give Compound 21A.

25 B. Compound XLIVa. The resultant compound of Example 21A was treated with 4-methoxybenzenesulfonyl chloride in a manner identical to that described in Example 10D to give Compound XLIVa. TLC: R<sub>f</sub> = 0.38, 40% ethyl acetate/hexanes. HPLC: R<sub>t</sub> = 17.19 min. <sup>1</sup>H NMR consistent with structure.

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Example 22

5 A. Compound 22A. To a solution of 64.3 mg of the resultant compound of Example 21B in 4.0 mL was added 151.5 mg of triphenylphosphine, 96.5 mg of p-nitrobenzoic acid and 0.577 mmol of diethyl azodicarboxylate. The reaction mixture was allowed to stir at room temperature for 4 days. The reaction mixture was concentrated in vacuo and purified by preparative thin layer chromatography (5% ethyl acetate/hexane) to give 21.2 mg of Compound 22A as a white, foaming solid.

15 B. Compound XLIVb. To a solution of 21.2 mg of the resultant compound of Example 22A in 1 mL of MeOH was added 0.5 mL of 1M NaOH. The reaction mixture was diluted with 1 mL of THF and was allowed to stir at room temperature for an additional 3h. The reaction mixture was concentrated in vacuo and purified by preparative thin layer chromatography (95:5 methylene chloride/ethyl acetate) to give 10.5 mg of pure compound XLIVb. TLC: R<sub>f</sub> = 0.38, 60:40 hexane/ethyl acetate. HPLC: R<sub>t</sub> = 17.20 min.

Example 23

25 A. The procedure described in Example 17A was performed using 3-nitrobenzenesulfonyl chloride (0.036 g, 0.161 mmol) and N-(4-cyclopentylmethylamino-2(S)-hydroxy)butyl-N-isobutyl-4-methoxybenzenesulfonamide (0.044 g, 0.108 mmol) to give the nitro sulfonamide in quantitative yield.

30 B. The procedure described in Example 6E was performed using the nitro sulfonamide prepared in

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Example 23A (0.064 g, 0.108 mmol) to give Compound 1041 (0.024 g, 39%). <sup>1</sup>H NMR consistent with structure.

#### Example 24

5 A. The procedure described in Example 1A was performed using N-(4-cyclopentylmethylamino-2(S)-hydroxy)butyl-N-isobutyl-4-methoxybenzenesulfonamide (0.075 g, 0.182 mmol) and 4-nitrobenzenesulfonyl chloride (0.081 g, 0.365 mmol) to give Compound 24A (0.074 g, 68%). <sup>1</sup>H NMR consistent with structure.

10 B. The procedure described in Example 6E was performed using Compound 24A (0.040 g, 0.067 mmol) to give Compound 1124 (0.025 g, 66%). <sup>1</sup>H NMR consistent with structure.

#### Example 25

15 Compound LXXVI. The resultant compound of Example 10F is treated with 4-(benzyloxycarbonyl)-2-(S)-N'-(t-butylcarboxamido)-piperazine in a manner similar to that described in Example 10G to give Compound LXXVI.

#### Example 26

20 A. Compound 26A. To a solution of 1.61 g of 4-nitrobenzyl chloroformate in 20 mL of methylene chloride cooled to 0°C was added 0.83 g of glycerol formal (prepared according to the method described in J-L. Gras et al., Tett. Lett., 28, p. 6601 (1987)) and  
25 0.9 mL of N-methylmorpholine. The reaction mixture was allowed to stir at room temperature overnight. The reaction mixture was diluted with ethyl acetate, washed with water, 0.5N HCl and brine, dried over magnesium sulfate and concentrated in vacuo. The resulting

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residue was recrystallized from methylene chloride/hexane to give 0.80 g of Compound 26A.

5 B. Compound LXVIII. The resultant compound of Example 13H is treated with the resultant compound of Example 26A in a manner similar to that described in Example 13I to give Compound LXVIII.

#### Example 27

10 A. Compound 27A. To a solution of 1.04 g of the resultant compound of Example 10A in 7 mL of THF was added 0.28 g of NaH at 0°C. After 5 min., 0.85 mL of benzyl bromide was added to the reaction mixture. After an additional 4h, the reaction mixture was diluted with 150 mL of diethyl ether and washed with water (two times) and brine. The organic phase was  
15 dried (MgSO<sub>4</sub>) and concentrated in vacuo. The resulting residue was purified by silica gel chromatography (10% ethyl acetate/hexane followed by 20% ethyl acetate/hexane) to give 1.15 g of Compound 27A.

20 B. Compound 27B. To a solution of 1.15 g of Compound 27A in 8 mL of MeOH was added 0.2 g of p-toluenesulfonic acid. The reaction mixture was allowed to stir for 60h at room temperature. The reaction mixture was concentrated in vacuo, diluted with methylene chloride and washed with water and brine.  
25 The organic layer was dried over MgSO<sub>4</sub> and concentrated in vacuo to give 1.47 g of Compound 27B.

C. Compound 27C. To a mixture of 110.9 mg of Compound 27B in 1.0 mL of methylene chloride cooled to -78°C was added 0.25 mL of diisopropylethylamine,  
30 followed by 0.565 mmol of methanesulfonyl chloride. The reaction mixture was allowed to warm to room

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temperature and was concentrated in vacuo to give a mixture of Compound 27C and the product of bis-mesylation.

5 D. Compound 27D. A solution of 1.25 g of Compound 27C and 4.0 mL of isobutylamine was heated for 6h at 60°C and was allowed to stir at room temperature overnight. The reaction mixture was concentrated in vacuo to give Compound 27D as a light, yellow semi-solid.

10 E. Compound 27E. The procedure described in Example 10D was performed using 1.145 g of Compound 27D (purification by silica gel chromatography: methylene chloride followed by 5% ethyl acetate/methylene chloride) to give 0.976 g of pure compound 27E. TLC:  
15 Rf = 0.42, 60:40 hexane/ethyl acetate.

F. Compound 27F. To a 200 mL round bottom flask containing 5 mL of MeOH was added 0.103 g of 10% Pd/C followed by a 25 mL solution of 0.976 g of Compound 27E in MeOH. The flask was fitted with a hydrogen-filled  
20 balloon and was allowed to stir for 60h at room temperature. The reaction mixture was filtered, concentrated in vacuo and purified by silica gel chromatography (3:2 ethyl acetate/methylene chloride) to give 0.6497 g of Compound 27F as a thick, colorless  
25 oil.

G. Compound 27G. To a 1 mL solution of 90.5 mg of Compound 27F in methylene chloride was added 0.410 mmol of diisopropylethylamine. The reaction mixture was cooled to -78°C, whereupon 0.273 mmol of  
30 methanesulfonyl chloride were added. The reaction

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mixture was allowed to warm to room temperature and was concentrated in vacuo to give 111.8 mg of Compound 27G.

5 H. Compound 27H. To a solution of 3.23 g of Compound 27E in 10 mL of diethyl ether was added 3.5 mL of 3,4-dihydro-2H-pyran. The reaction mixture was allowed to stir at room temperature for 60h. The reaction mixture was diluted with ethyl acetate, washed with water (two times) and brine, dried over magnesium sulfate and concentrated in vacuo to give 4.01 g of Compound 27H as  
10 a colorless oil. <sup>1</sup>H NMR consistent with structure.

I. Compound 27I. To a solution of 3.87 g of Compound 27H in 30 mL of MeOH was added 800 mg of 10% Pd/C. The reaction mixture was placed in a hydrogenating apparatus under a pressure of 35 psi. After 6h, more  
15 catalyst was added and the pressure was increased to 45 psi. The hydrogenolysis was allowed to proceed overnight, whereupon still more catalyst was added. The reaction was allowed to proceed at 42 psi overnight. The reaction mixture was filtered and  
20 concentrated in vacuo to give 3.33 g of Compound 27I as a thick, colorless oil. <sup>1</sup>H NMR consistent with structure.

J. Compound 27J. To a solution of 0.66g of Compound 27I in 4 mL of DMF was added 2.09 g of pyridinium  
25 dichromate. The reaction mixture was allowed to stir at room temperature overnight. The reaction mixture was poured into 15 mL of water and extracted into diethyl ether (five times). The combined organic layers were washed with brine, dried over magnesium sulfate, filtered and concentrated in vacuo to give a  
30 colorless oil. The resulting colorless oil was

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purified by medium pressure liquid chromatography to give 0.19 of Compound 27J.

5 K. Compound LXXXII. To a solution of Compound 27J in DMF is added 1 eq. of S-thiaproline t-butylamide, 1 eq. of EDC and 1 eq. of HOBT. The reaction mixture is diluted with ethyl acetate and washed with saturated, aqueous sodium bicarbonate and brine. The organic phase is concentrated in vacuo and purified by silica gel chromatography to give a THP-protected product.

10 The THP-protected product is dissolved in MeOH and treated with catalytic p-toluenesulfonic acid. The reaction mixture is concentrated in vacuo and purified by silica gel chromatography to give Compound LXXXII.

#### Example 28

15 A. Compound 28A. To a solution of 2.0607 g of S-(+)-5-trityloxymethyl-  
-gamma-butyrolactone in 1 mL of THF cooled to -78°C was added 5.749 mmol of  $\text{LiN}(\text{TMS})_2$  as a 1M solution in THF. The reaction mixture was allowed to stir for 0.5h,

20 whereupon 5.75 mL of benzyl bromide were added. The reaction mixture was allowed to stir overnight. The reaction mixture was quenched with 0.5N HCl, extracted into ethyl acetate, concentrated in vacuo and purified by silica gel chromatography (20% ethyl acetate/hexane)

25 to give 0.8834 g of Compound 28A.

B. Compound 28B. To a solution of 0.1899 g of the resultant compound of Example 28A in 1 mL of methylene chloride was added approximately 3 mL of trifluoroacetic acid. The reaction mixture was allowed to stir at room

30 temperature for 2h. The reaction mixture was concentrated in vacuo and purified by silica gel chromatography (100% methylene chloride followed by 20%

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diethyl ether/methylene chloride) to give 47.5 mg of Compound 28B.

- 5 C. Compound 28C. To a solution of 47.5 mg of the resultant compound of Example 28B in methylene chloride cooled to  $-10^{\circ}\text{C}$  was added 0.0443 mL of triethylamine and 0.023 mL of methanesulfonyl chloride. The reaction mixture was allowed to stir overnight at room temperature. The reaction mixture was concentrated in vacuo to give Compound 28C.
- 10 D. Compound 28D. To the resultant compound of Example 28C was added excess iso-butylamine. The reaction mixture was allowed to stir at room temperature overnight. The reaction mixture was concentrated in vacuo to give Compound 28D.
- 15 E. Compound LI'. The procedure described in Example 10D was performed using the resultant compound of Example 28D (purification by silica gel chromatography: 0-10% diethyl ether/methylene chloride) to give 22.7 mg of Compound LI'.  $^1\text{H}$  NMR consistent with structure.
- 20 TLC:  $R_f = 0.32$ , 10% diethyl ether/methylene chloride.

#### Example 29

- 25 A. Benzyl chloroformate (0.919 g, 5.38 mmol) was added to a solution of cyclopentylmethylanine (0.445 g, 4.49 mmol) and DIEA (1.74 g, 13.5 mmol) in 50 mL of  $\text{CH}_2\text{Cl}_2$  and the mixture was stirred overnight at R.T. The mixture was concentrated in vacuo and the residue was taken up in EtOAc, washed with water, sat. aq.  $\text{NaHCO}_3$ , brine, dried over  $\text{MgSO}_4$  and concentrated to give the crude N-Cbz-cyclopentylmethylanine (1.275 g) which

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was used without further purification.  $^1\text{H}$  NMR consistent with structure.

5 B. The procedure described in Example 4A was performed using N-Cbz-cyclopentylmethylaniline (1.275 g, crude material) to give the epoxide (0.517 g, 40%).  $^1\text{H}$  NMR consistent with structure.

10 C. The procedure described in Example 5A was performed using the epoxide prepared in Example 29B (0.260 g, 0.899 mmol) to give the amine (0.200 g, 54%).  $^1\text{H}$  NMR consistent with structure.

15 D. The procedure described in Example 29A was performed using isonicotinoyl chloride hydrochloride (0.077 g, 0.435 mmol) and the amine prepared in Example 29C (0.119 g, 0.290 mmol) to give the Cbz-amine.  $^1\text{H}$  NMR consistent with structure.

20 E. The procedure described in Example 6E was performed using the Cbz-amine prepared in Example 29D (0.039 g, 0.071 mmol) to give the free amine (0.036 g, crude material) which was used without further purification.  $^1\text{H}$  NMR consistent with structure.

25 F. 3-nitrobenzenesulfonyl chloride (0.025 g, 0.113 mmol) was added to a solution of the amine prepared in Example 29E (0.036 g, crude material) and DIEA (0.037 g, 0.28 mmol) in 10 mL of  $\text{CH}_2\text{Cl}_2$  and the mixture was stirred overnight at R.T. The mixture was concentrated in vacuo and the residue was taken up in EtOAc, washed with water, sat. aq.  $\text{NaHCO}_3$ , brine, dried over  $\text{MgSO}_4$  and concentrated. Purification by silica gel column

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chromatography (3% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) gave the nitro sulfonamide (0.011 g, 28% over 2 steps). <sup>1</sup>H NMR consistent with structure.

5 G. The procedure described in Example 6E was performed using the nitro sulfonamide prepared in Example 29F (0.011 g, 0.020 mmol) to give Compound 1045 (0.006 g, 59%). <sup>1</sup>H NMR consistent with structure.

#### Example 30

10 A. A 1.6M solution of n-BuLi in hexanes (0.705 mL, 1.13 mmol) was added to a solution of (S)-(-)-4-benzyl-2-oxazolidinone (0.200 g, 1.13 mmol) in 10 mL of THF at -78 °C. After 20 min., epibromohydrin (0.139 g, 1.02 mmol) was added. The mixture was stirred 30 min. then was allowed to warm to R.T. and stirred for 2 days.  
15 The mixture was quenched with MeOH and concentrated. The residue was taken up in EtOAc and washed with sat. aq. NaHCO<sub>3</sub>, brine, dried over MgSO<sub>4</sub> and concentrated. The crude material was purified by silica gel column chromatography (5% Et<sub>2</sub>O/CH<sub>2</sub>Cl<sub>2</sub>) to give the epoxide  
20 (0.024 g, 9%). <sup>1</sup>H NMR consistent with structure.

B. The procedure described in Example 1C was performed using the epoxide prepared in Example 30A (0.024 g, 0.102 mmol) and cyclopentylmethylaniline (0.051 g, 0.515 mmol) to give the amine (0.034 g, quant.).  
25 <sup>1</sup>H NMR consistent with structure.

C. The procedure described in Example 29F was performed using 4-methoxybenzenesulfonyl chloride (0.032 g, 0.153 mmol) and the amine prepared in Example 30B (0.034 g, 0.102 mmol) to give two separable

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diastereomers (SiO<sub>2</sub>, 3x0.5 mm plates, 5% MeOH/CH<sub>2</sub>Cl<sub>2</sub>)  
Compound 1046A (0.018 g, R<sub>f</sub>=0.51, 5% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) and  
Compound 1046B (0.018 g, R<sub>f</sub>=0.45, 5% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) which  
gave a combined yield of 65%. <sup>1</sup>H NMR consistent with  
structures.

### Example 31

A. The procedure described in Example 4A was  
performed using 4-phenyl-1,2,3,4-  
tetrahydroisoquinolinone (0.028 g, 0.143 mmol) to give  
the epoxide. <sup>1</sup>H NMR consistent with structure.

B. The procedure described in Example 30B was  
performed using the epoxide prepared in Example 31A to  
give the amine (0.008 g). <sup>1</sup>H NMR consistent with  
structure.

C. The procedure described in Example 30C was  
performed using the amine prepared in Example 31B to  
give Compound 1048 (0.002 g, 21%, R<sub>f</sub>=0.36, 3%  
MeOH/CH<sub>2</sub>Cl<sub>2</sub>).

### Example 32

Using the method described by Pennington et  
al. (supra), we obtained inhibition constants for the  
following compounds of this invention:

	<u>Compound</u>	<u>K<sub>i</sub> (nM)</u>
	XLII	2,400
	XLIVa	400
	XLVIII	3,300
	XLV	160

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	LVa	167
	LI	5,000
	LII	11
	LXXVI	2,700
5	1000	100
	1001	30
	1002	16,000
	1003	1,200
	1004	1,300
10	1005	15
	1006	470
	1007	35
	1008	260
	1009	120
15	1010	125
	1011	110
	1012	200
	1013	50
	1014	130
20	1015	17
	1016	75
	1017	110
	1018	65
	1019	20
25	1020	170
	1021	70
	1022	170
	1023	52
	1024	66
30	1025	270
	1026	20
	1027	7
	1028	800
	1029	3,500
35	1031	1,400
	1033	1,600
	1034	1,100
	1035	3,600
	1036	8,000
40	1037	>10,000
	1038	>10,000
	1039	>3,000
	1040	>10,000
	1041	270
45	1044	220
	1045	14
	1046	1,200
	1047	1,600
	1048	3,300

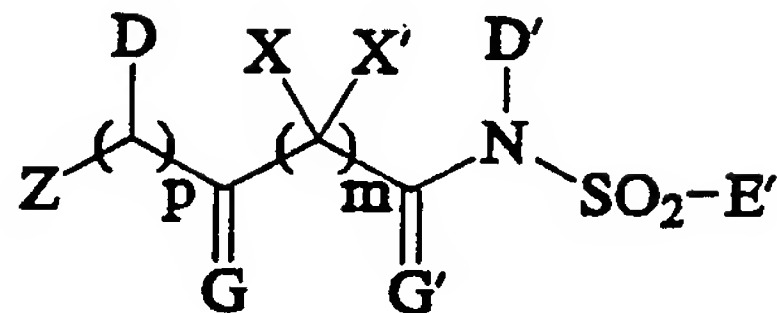
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While we have described a number of  
embodiments of this invention, it is apparent that our  
basic constructions may be altered to provide other  
embodiments which utilize the products and processes of  
5 this invention. Therefore, it will be appreciated that  
the scope of this invention is to be defined by the  
appended claims, rather than by the specific  
embodiments which have been presented by way of  
example.

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## WE CLAIM:

1. A compound of formula I:



( I )

wherein:

each Z is selected from the group consisting of -  
 5 N(D)SO<sub>2</sub>E; -N(H)A; -N(D)A; -N(H)E; -N(H)C(O)N(D)(E); -  
 N(H)-Het; -Het and -N(D)-Het;

each A is independently selected from the group  
 consisting of H; Het; -R<sup>1</sup>-Het; -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl, which may  
 10 be optionally substituted with one or more groups, the  
 same or different, selected from the group consisting  
 of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>),  
 -NR<sup>2</sup>-CO-OR<sup>2</sup> and -CO-N(R<sup>2</sup>)(R<sup>2</sup>); and -R<sup>1</sup>-C<sub>2</sub>-C<sub>6</sub> alkenyl, which  
 may be optionally substituted with one or more groups,  
 the same or different, selected from the group  
 15 consisting of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het, -NR<sup>2</sup>-  
 CO-N(R<sup>2</sup>)(R<sup>2</sup>) and -CO-N(R<sup>2</sup>)(R<sup>2</sup>);

each Het is independently selected from the group  
 consisting of C<sub>3</sub>-C<sub>7</sub> cycloalkyl; C<sub>5</sub>-C<sub>7</sub> cycloalkenyl; C<sub>6</sub>-C<sub>10</sub>  
 aryl; phenyl fused with heterocycle; and heterocycle;  
 20 wherein any member of said Het may be optionally  
 substituted with one or more substituents, the same or  
 different, selected from the group consisting of oxo, -  
 OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NHOH, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-  
 N(R<sup>2</sup>)(R<sup>2</sup>), -S(O)<sub>2</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -C(O)-R<sup>2</sup>, -  
 25 S(O)<sub>n</sub>-R<sup>2</sup>, -OCF<sub>3</sub>, -S(O)<sub>n</sub>-D, -N(R<sup>2</sup>)-S(O)<sub>2</sub>(R<sup>2</sup>), halo, -CF<sub>3</sub>, -  
 NO<sub>2</sub>, -R<sup>6</sup>, -O-R<sup>6</sup>, -C(O)N(D)(D) and -C(O)N(H)D;

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each D and D' is independently selected from the group consisting of R<sup>6</sup>; -N(R<sup>2</sup>)(R<sup>2</sup>); C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups, the same or different, selected from C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-R<sup>6</sup>, -S-R<sup>6</sup> and R<sup>6</sup>; C<sub>2</sub>-C<sub>4</sub> alkenyl, which may be optionally substituted with one or more groups, the same or different, selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-R<sup>6</sup> and R<sup>6</sup>; C<sub>3</sub>-C<sub>6</sub> cycloalkyl, which may be optionally substituted with or fused with R<sup>6</sup>; and C<sub>5</sub>-C<sub>6</sub> cycloalkenyl, which may be optionally substituted with or fused with R<sup>6</sup>;

each E and E' is independently selected from the group consisting of Het; -O-Het; Het-Het; -O-R<sup>3</sup>; -NR<sup>2</sup>R<sup>3</sup>; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups, the same or different, selected from the group consisting of R<sup>4</sup> and Het; and C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally substituted with one or more groups, the same or different, selected from the group consisting of R<sup>4</sup> and Het;

each R<sup>1</sup> is independently selected from the group consisting of -C(O)-, -S(O)<sub>2</sub>-, -C(O)-C(O)-, -O-C(O)-, -O-S(O)<sub>2</sub>-, -NR<sup>2</sup>-S(O)<sub>2</sub>-, -NR<sup>2</sup>-C(O)- and -NR<sup>2</sup>-C(O)-C(O)-;

each R<sup>2</sup> is independently selected from the group consisting of H, R<sup>6</sup>, and C<sub>1</sub>-C<sub>4</sub> alkyl optionally substituted with R<sup>6</sup>;

each R<sup>3</sup> is independently selected from the group consisting of H, Het, C<sub>1</sub>-C<sub>6</sub> alkyl and C<sub>2</sub>-C<sub>6</sub> alkenyl wherein any member of said R<sup>3</sup>, except H, may be optionally substituted with one or more substituents, the same or different, selected from the group consisting of -OR<sup>2</sup>, -C(O)-NH-R<sup>2</sup>, -S(O)<sub>n</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), Het, -CN, -SR<sup>2</sup>, -CO<sub>2</sub>R<sup>2</sup>, NR<sup>2</sup>-C(O)-R<sup>2</sup>;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -C(O)-NHR<sup>2</sup>, -S(O)<sub>2</sub>-NHR<sup>2</sup>, halo, -NR<sup>2</sup>-

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$C(O)-R^2$ ,  $-CN$ ,  $-N(R^2)(R^2)$ ,  $-NO_2$ ,  $-C(O)N(D)(D)$  and  $-C(O)N(H)D$ ;

each  $R^5$  is independently selected from the group consisting of H and  $C_1-C_3$  alkyl;

5 each  $R^6$  is independently selected from the group consisting of aryl, carbocycle and heterocycle, wherein said carbocycle or heterocycle may be optionally substituted with one or more groups, the same or different, selected from the group consisting of oxo, -  
10  $OR^5$ ,  $-R^5$ ,  $-N(R^5)(R^5)$ ,  $-N(R^5)-C(O)-R^5$ ,  $-R^5-OH$ ,  $-CN$ ,  $-CO_2R^5$ ,  $-C(O)-N(R^5)(R^5)$ , halo and  $-CF_3$ ;

each n is independently 1 or 2;

m is an integer selected from 1, 2 and 3;

p is an integer selected from 0 and 1;

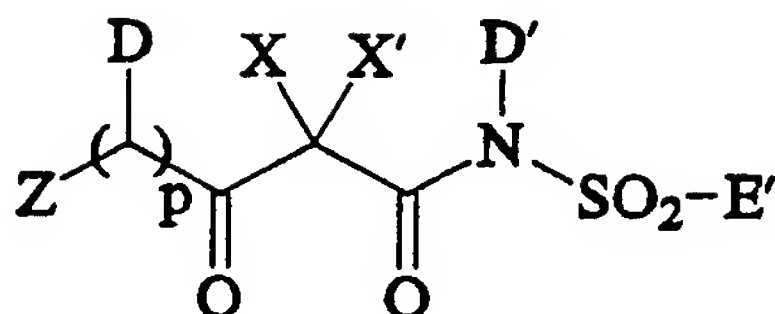
15 each G and G' is independently selected from the group consisting of  $H_2$  and O; and

each X and X' is independently selected from the group consisting of hydrogen;  $-OH$ ;  $-NH_2$ ;  $-SH$ ; D; halogen and, if X and X' are taken together, oxygen.

20 2. The compound according to claim 1, wherein E' is selected from the group consisting of -Het and  $-R^2$ -Het.

3. The compound according to claim 1 or 2 having the structure of formula IV:

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( IV )

4. The compound according to claim 3, wherein:  
 each D and D' is independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sub>6</sub>;

5 each E' is independently selected from C<sub>5</sub>-C<sub>6</sub> aryl, which may be optionally substituted with R<sup>4</sup>;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

10 each Z is independently selected from the group consisting of -N(D)SO<sub>2</sub>E; -N(H)Het; -N(H)A; -N(D)A and -Het;

15 each Het is independently selected from the group consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered saturated or unsaturated heterocycle, wherein any member of said Het may be optionally substituted with one or more substituents, the same or different, selected from the group consisting of -OR<sup>2</sup>, R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(R<sup>2</sup>)(R<sup>2</sup>) and -S(O)<sub>n</sub>-R<sup>6</sup>;

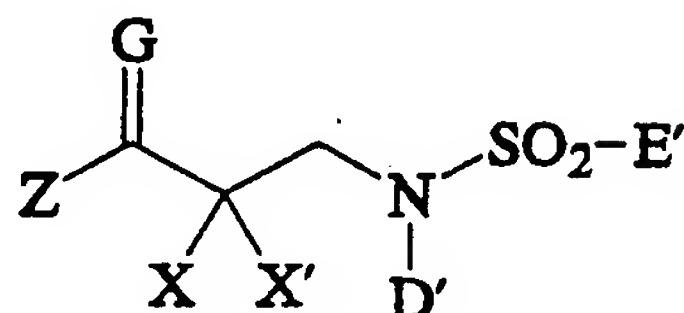
20 each X and X' is independently selected from the group consisting of H, -OH and, most preferably, if X and X' are taken together, oxygen;

each A is independently selected from the group consisting of H; -R<sup>1</sup>-Het and -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl; and

25 each R<sup>1</sup> is independently selected from the group consisting of -C(O)- and -O-C(O)-.

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5. The compound according to claim 1 or 2 having the structure of formula VI:



( VI )

6. The compound according to claim 5, wherein:

5 each D and D' is independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sup>6</sup>;

each X and X' is independently selected from the group consisting of H, OH, and if X and X' are taken together, oxygen;

10 each E' is independently selected from C<sub>5</sub>-C<sub>6</sub> unsaturated carbocycle, which may be optionally substituted with R<sup>4</sup>;

each R<sup>4</sup> is independently selected from the group consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

15 each Z is selected from the group consisting of -N(D)SO<sub>2</sub>E; -N(H)Het; -N(H)A; -N(D)A and -Het;

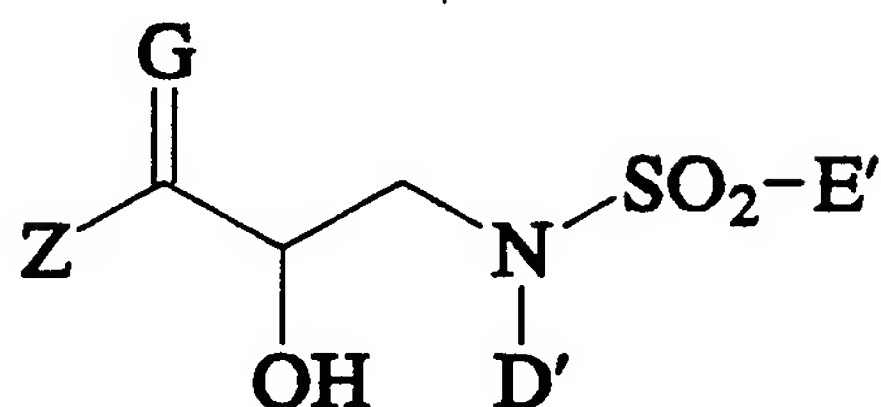
20 each Het is independently selected from the group consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered saturated or unsaturated heterocycle, and wherein any member of said Het may be optionally substituted with one or more substituents, the same or different, selected from the group consisting of -OR<sup>2</sup>, R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NO<sub>2</sub>, -C(O)N(R<sup>2</sup>)(R<sup>2</sup>) and -S(O)<sub>n</sub>-R<sup>6</sup>;

25 each A is selected from the group consisting of H; -R<sup>1</sup>-Het and -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl; and

each R<sup>1</sup> is independently selected from the group consisting of -C(O)- and -O-C(O)-.

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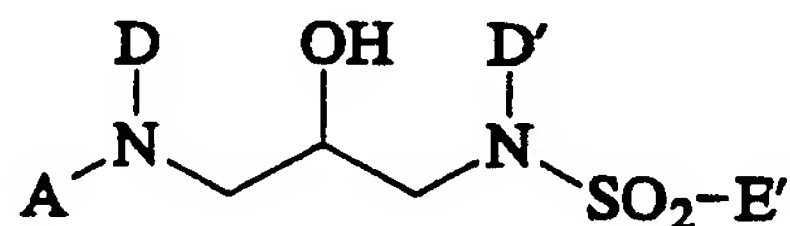
7. The compound according to claim 6 having the structure of formula CIII:



( CIII )

8. The compound according to claim 7, selected from the group consisting of: 1000, 1001, 1005, 1007, 1008, 1009, 1010, 1011, 1012, 1013, 1014, 1015, 1016, 1017, 1018, 1019, 1020, 1021, 1022, 1023, 1024, 1025, 1026, 1027, and 1044.

9. The compound according to claim 7 having the structure of formula LVIIa:



( LVIIa )

10 wherein:

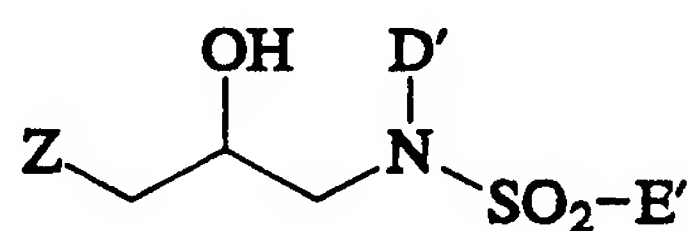
each A is selected from the group consisting of  $\text{R}^1$ -Het and  $\text{R}^1$ -C<sub>1</sub>-C<sub>6</sub> alkyl substituted with  $\text{N}(\text{R}^2)$ -CO-N(R<sup>2</sup>) (R<sup>2</sup>) or  $\text{N}(\text{R}^2)$ -CO-O-R<sup>2</sup>; and

15 each R<sup>1</sup> is independently selected from the group consisting of -C(O)- and -O-C(O)-.

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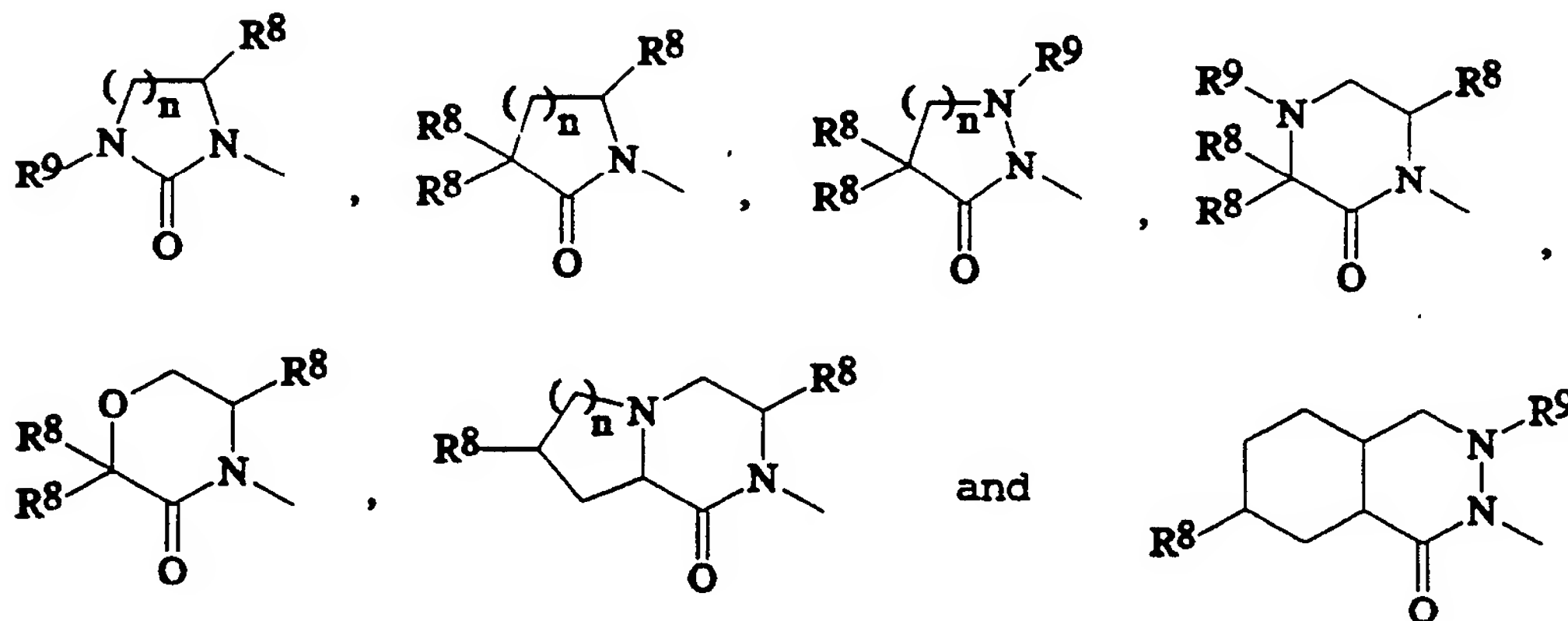
10. The compound according to claim 9, wherein each D and D' are independently selected from the group C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sup>6</sup>.

5 11. The compound according to to claim 7 having the structure of formula LVIIb:



( LVIIb )

wherein Z is selected from the group consisting of:

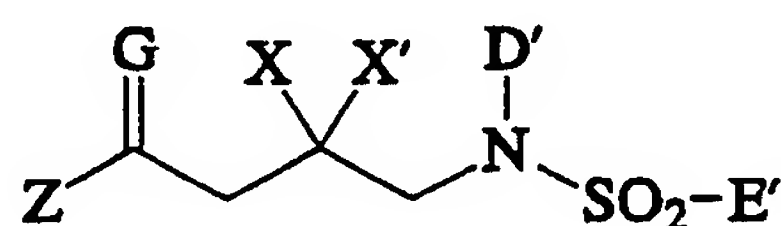


10 wherein R<sup>8</sup> is selected from the group consisting of R<sup>2</sup>, -N-C(O)-O-R<sup>2</sup> and -N-C(O)-R<sup>2</sup>; R<sup>9</sup> is selected from the group consisting of R<sup>2</sup>, -C(O)-O-R<sup>2</sup> and -C(O)-R<sup>2</sup> and R<sup>2</sup> is as defined in claim 1.

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12. The compound according to claim 11,  
wherein D and D' are each independently C<sub>1</sub>-C<sub>6</sub> alkyl  
which may be optionally substituted with R<sup>6</sup>.

13. The compound according to claim 1 or 2 having  
the structure of formula VII:



( VII )

14. The compound according to claim 13, wherein:  
each D and D' is C<sub>1</sub>-C<sub>6</sub> alkyl, which may be  
optionally substituted with R<sup>6</sup>;

G is H<sub>2</sub>;

10 each X and X' is independently selected from the  
group consisting of H, OH, and if X and X' are taken  
together, oxygen;

each E' is independently selected from C<sub>5</sub>-C<sub>6</sub> aryl,  
which may be optionally substituted with R<sup>4</sup>;

15 each R<sup>1</sup> is selected from the group consisting of -  
C(O)- and -O-C(O)-;

each R<sup>4</sup> is independently selected from the group  
consisting of -OR<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>) and -NO<sub>2</sub>;

20 each Z is selected from the group consisting of -  
N(H)Het; -N(H)A; -N(D)SO<sub>2</sub>E; -N(D)A and -Het;

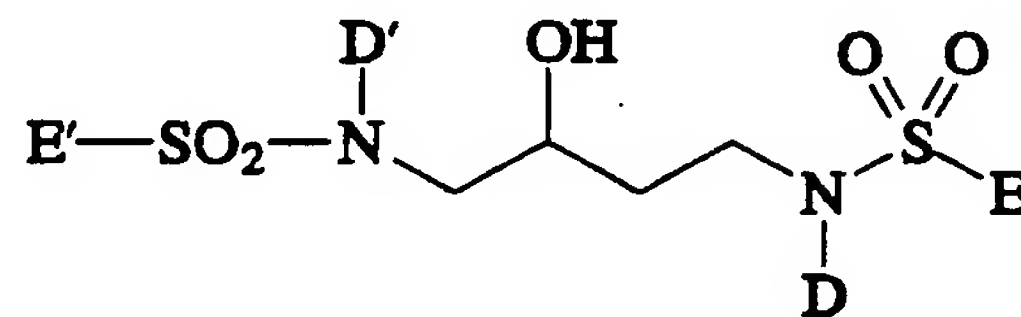
each Het is independently selected from the group  
consisting of C<sub>6</sub>-C<sub>10</sub> aryl and 5-10 membered saturated or  
unsaturated heterocycle, and wherein any member of said  
Het may be optionally substituted with one or more  
25 substituents, the same or different, selected from the

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group consisting of  $-OR^2$ ,  $R^2$ ,  $-N(R^2)(R^2)$ ,  $-NO_2$ ,  $-C(O)N(R^2)(R^2)$  and  $-S(O)_n-R^6$ ; and

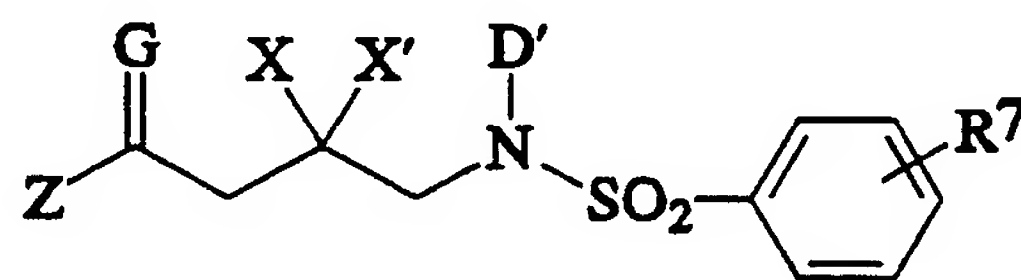
each A is selected from the group consisting of H;  $-R^1$ -Het and  $-R^1-C_1-C_6$  alkyl.

- 5            15. The compound according to claim 13 having the structure of formula CIV:



( CIV )

16. The compound according to claim 13 having the structure of formula LXII:



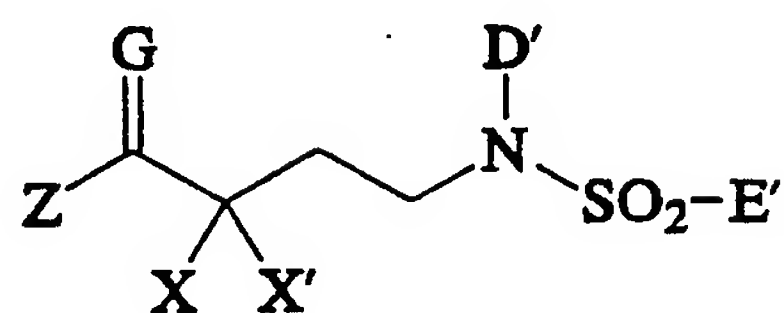
( LXII )

- 10            wherein  $R^7$  is selected from the group consisting of H,  $-OH$ ,  $-OR^2$ ,  $-R^2$ ,  $-N(R^2)(R^2)$ ,  $-N(R^2)-C(O)-R^2$ ,  $-R^2-OH$ ,  $-CN$ ,  $-CO_2R^2$ ,  $-C(O)-N(R^2)(R^2)$ , halo and  $-CF_3$ .

17. The compound according to claim 16, selected from the group consisting of: XLIVa, XLV, LVa, and 1041.

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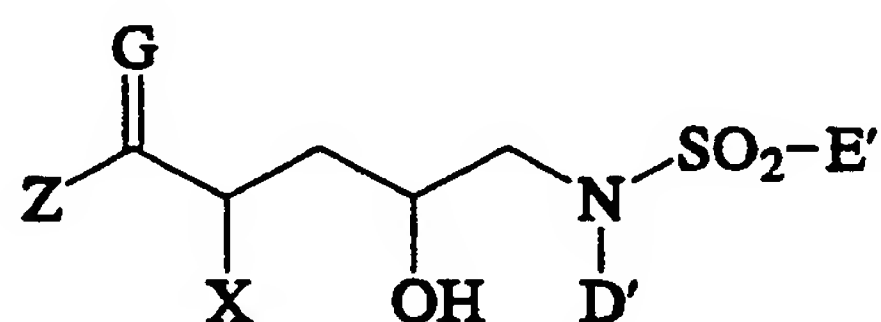
18. The compound according to claim 1 or 2,  
having the structure of formula C:



( C )

19. The compound according to claim 18, wherein Z  
is selected from the group consisting of -N(H)Het; -  
5 N(H)A; -N(D)A and -Het.

20. The compound according to claim 1 having the  
structure of formula CI:



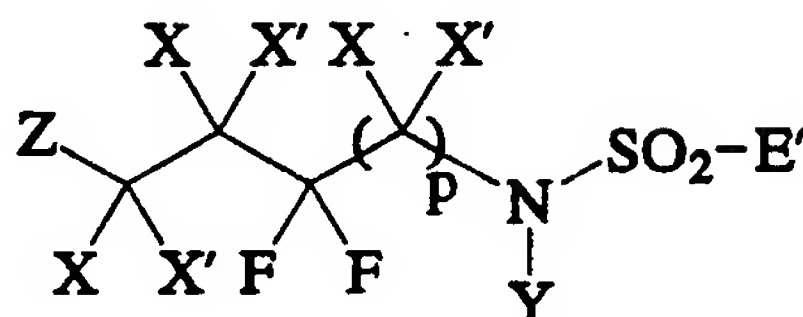
( CI )

21. The compound according to claim 20, wherein X  
is a C<sub>1</sub> alkyl substituted with R<sup>6</sup> and D' is a C<sub>1</sub>-C<sub>4</sub>  
10 alkyl optionally substituted with R<sup>6</sup>.

22. The compound according to claim 20, selected  
from the group consisting of: LI and LII.

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23. A compound of formula II:



( II )

wherein:

each Z is selected from the group consisting of -  
 N(D)SO<sub>2</sub>E; -N(H)A; -N(D)A; -N(H)E; -N(H)C(O)N(D)(E); -  
 5 N(H)-Het; -Het and -N(D)-Het;

each A is independently selected from the group  
 consisting of H; Het; -R<sup>1</sup>-Het; -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl, which may  
 be optionally substituted with one or more groups, the  
 same or different, selected from the group consisting  
 10 of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>),  
 -NR<sup>2</sup>-CO-OR<sup>2</sup> and -CO-N(R<sup>2</sup>)(R<sup>2</sup>); and -R<sup>1</sup>-C<sub>2</sub>-C<sub>6</sub> alkenyl, which  
 may be optionally substituted with one or more groups,  
 the same or different, selected from the group  
 consisting of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het, -NR<sup>2</sup>-  
 15 CO-N(R<sup>2</sup>)(R<sup>2</sup>) and -CO-N(R<sup>2</sup>)(R<sup>2</sup>);

each Het is independently selected from the group  
 consisting of C<sub>3</sub>-C<sub>7</sub> cycloalkyl; C<sub>5</sub>-C<sub>7</sub> cycloalkenyl; C<sub>6</sub>-C<sub>10</sub>  
 aryl; phenyl fused heterocycle; and heterocycle;  
 wherein any member of said Het may be optionally  
 20 substituted with one or more substituents, the same or  
 different, selected from the group consisting of oxo, -  
 OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -NHOH, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-  
 N(R<sup>2</sup>)(R<sup>2</sup>), -S(O)<sub>2</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -C(O)-R<sup>2</sup>, -  
 S(O)<sub>n</sub>-R<sup>2</sup>, -OCF<sub>3</sub>, -S(O)<sub>n</sub>-D, -N(R<sup>2</sup>)-S(O)<sub>2</sub>(R<sup>2</sup>), halo, -CF<sub>3</sub>, -  
 25 NO<sub>2</sub>, -R<sup>6</sup>, -O-R<sup>6</sup>, -C(O)N(D)(D) and -C(O)N(H)D;

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each D is independently selected from the group consisting of  $R^6$ ;  $-N(R^2)(R^2)$ ;  $C_1-C_6$  alkyl, which may be optionally substituted with one or more groups, the same or different, selected from  $C_3-C_6$  cycloalkyl,  $-OR^2$ ,  $-R^3$ ,  $-O-R^6$ ,  $-S-R^6$  and  $R^6$ ;  $C_2-C_4$  alkenyl, which may be optionally substituted with one or more groups, the same or different, selected from the group consisting of  $C_3-C_6$  cycloalkyl,  $-OR^2$ ,  $-R^3$ ,  $-O-R^6$  and  $R^6$ ;  $C_3-C_6$  cycloalkyl, which may be optionally substituted with or fused with  $R^6$ ; and  $C_5-C_6$  cycloalkenyl, which may be optionally substituted with or fused with  $R^6$ ;

each E is selected from the group consisting of Het;  $-O-Het$ ; Het-Het;  $-O-R^3$ ;  $-NR^2R^3$ ;  $C_1-C_6$  alkyl, which may be optionally substituted with one or more groups, the same or different, selected from the group consisting of  $R^4$  and Het; and  $C_2-C_6$  alkenyl, which may be optionally substituted with one or more groups, the same or different, selected from the group consisting of  $R^4$  and Het;

each  $R^1$  is independently selected from the group consisting of  $-C(O)-$ ,  $-S(O)_2-$ ,  $-C(O)-C(O)-$ ,  $-O-C(O)-$ ,  $-O-S(O)_2$ ,  $-NR^2-S(O)_2-$ ,  $-NR^2-C(O)-$  and  $-NR^2-C(O)-C(O)-$ ;

each  $R^2$  is independently selected from the group consisting of H,  $R^6$ , and  $C_1-C_4$  alkyl optionally substituted with  $R^6$ ;

each  $R^3$  is independently selected from the group consisting of H, Het,  $C_1-C_6$  alkyl and  $C_2-C_6$  alkenyl wherein any member of said  $R^3$ , except H, may be optionally substituted with one or more substituents, the same or different, selected from the group consisting of  $-OR^2$ ,  $-C(O)-NH-R^2$ ,  $-S(O)_n-N(R^2)(R^2)$ , Het,  $-CN$ ,  $-SR^2$ ,  $-CO_2R^2$ ,  $NR^2-C(O)-R^2$ ;

each  $R^4$  is independently selected from the group consisting of  $-OR^2$ ,  $-C(O)-NHR^2$ ,  $-S(O)_2-NHR^2$ , halo,  $-NR^2-$

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$C(O)-R^2$ ,  $-CN$ ,  $-N(R^2)(R^2)$ ,  $-NO_2$ ,  $-C(O)N(D)(D)$  and  $-C(O)N(H)D$ ;

each  $R^5$  is independently selected from the group consisting of H and  $C_1-C_3$  alkyl;

5 each  $R^6$  is independently selected from the group consisting of aryl, carbocycle and heterocycle, wherein said carbocycle or heterocycle may be optionally substituted with one or more groups, the same or different, selected from the group consisting of oxo, -  
 10  $OR^5$ ,  $-R^5$ ,  $-N(R^5)(R^5)$ ,  $-N(R^5)-C(O)-R^5$ ,  $-R^5-OH$ ,  $-CN$ ,  $-CO_2R^5$ ,  $-C(O)-N(R^5)(R^5)$ , halo and  $-CF_3$ ;

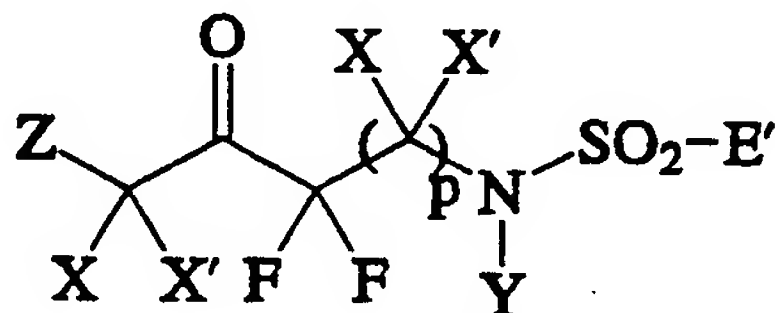
p is an integer selected from 0 and 1;

each X and X' is independently selected from the group consisting of hydrogen;  $-OH$ ;  $-NH_2$ ;  $-SH$ ; D; halogen  
 15 and, if X and X' are taken together, oxygen; and

each Y is independently selected from the group consisting of hydrogen and D.

24. The compound according to claim 23, wherein X and X' on the carbon adjacent to the carbon bearing Z on the backbone, taken together, are oxygen.  
 20

25. The compound according to claim 23 having the structure of formula VIII:



( VIII )

26. The compound according to claim 25 wherein:

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on the carbon bearing Z, X is H and X' is D;

D is selected from the group consisting of isobutyl, benzyl, and cyclopentylmethyl;

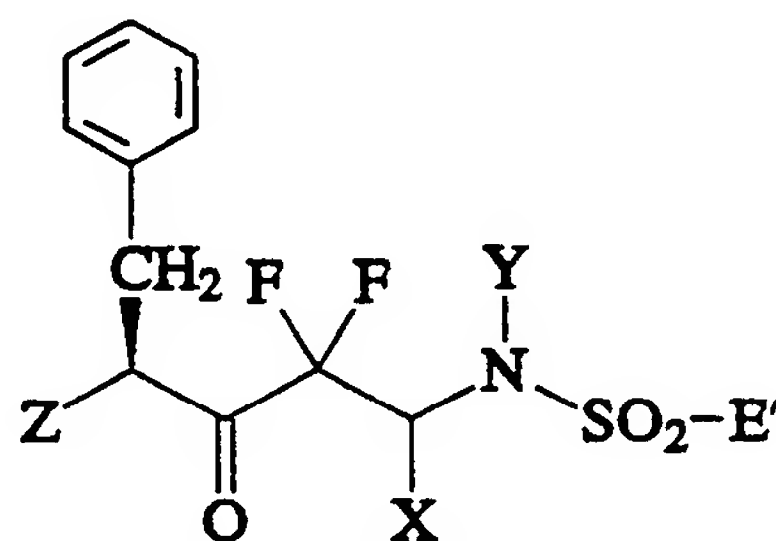
5 on the carbon adjacent to N-Y, X and X' are independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub> alkyl and H;

Y is selected from the group consisting of C<sub>1</sub>-C<sub>6</sub> alkyl and H;

10 E is C<sub>6</sub>-C<sub>10</sub> aryl optionally substituted with OCH<sub>3</sub> or NH<sub>2</sub>; and

Z is (3S)-tetrahydrofuran-3-yl-OC(O)NH- or 5-(1,3-dioxanyl)-OC(O)NH-.

27. The compound according to claim 25 having the structure of formula CV:

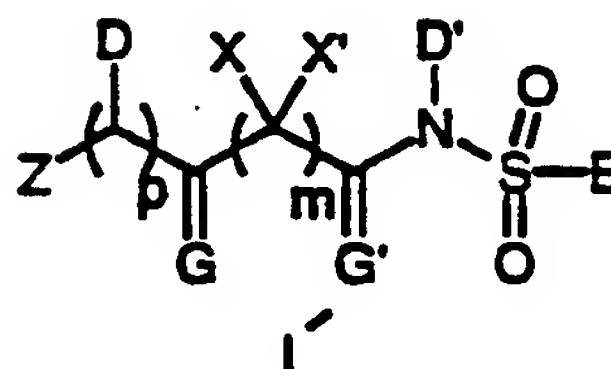


( CV )

15 28. The compound according to claim 27, wherein X and Y are independently selected from the group consisting of H or C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with R<sup>6</sup>; and Z is selected from the group consisting of -N(H) (A) and -N(D) (A).

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29. A compound of formula I' :



wherein:

each D and D' is independently selected from the group consisting of Ar; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-Ar and Ar; C<sub>2</sub>-C<sub>4</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of C<sub>3</sub>-C<sub>6</sub> cycloalkyl, -OR<sup>2</sup>, -R<sup>3</sup>, -O-Ar and Ar; C<sub>3</sub>-C<sub>6</sub> cycloalkyl, which may be optionally substituted with or fused with Ar; and C<sub>5</sub>-C<sub>6</sub> cycloalkenyl, which may be optionally substituted with or fused with Ar;

each Ar is independently selected from the group consisting of phenyl; 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S, S(O)<sub>n</sub> and N(R<sup>2</sup>), wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of oxo, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>;

each R<sup>2</sup> is independently selected from the group consisting of H and C<sub>1</sub>-C<sub>4</sub> alkyl optionally substituted with phenyl, 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S and S(O)<sub>n</sub>, wherein said carbocyclic or

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heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of OH, NH<sub>2</sub>, CN, C<sub>1</sub>-C<sub>4</sub> alkyl, C<sub>1</sub>-C<sub>4</sub> alkoxy, halogen and CF<sub>3</sub>;

5 each R<sup>3</sup> is independently selected from the group consisting of H, Het, C<sub>1</sub>-C<sub>6</sub> alkyl, C<sub>2</sub>-C<sub>6</sub> alkenyl, C<sub>3</sub>-C<sub>6</sub> cycloalkyl and C<sub>5</sub>-C<sub>6</sub> cycloalkenyl, wherein any member of said R<sup>3</sup>, except H, may be optionally substituted with one or more substituents selected from  
 10 the group consisting of -OR<sup>2</sup>, -C(O)-NH-R<sup>2</sup>, -S(O)<sub>n</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), Het, -CN, -SR<sup>2</sup>, -CO<sub>2</sub>R<sup>2</sup> and NR<sup>2</sup>-C(O)-R<sup>2</sup>;

each Het is independently selected from the group consisting of C<sub>3</sub>-C<sub>7</sub> cycloalkyl; C<sub>5</sub>-C<sub>7</sub> cycloalkenyl; C<sub>6</sub>-C<sub>10</sub> aryl; and 5-10 membered saturated or unsaturated  
 15 heterocycle, containing one or more heteroatoms selected from the group consisting of N, N(R<sup>2</sup>), O, S and S(O)<sub>n</sub>, wherein said heterocycle may optionally be benzofused; wherein said heterocycle may be bicyclic or monocyclic; and wherein any member of said Het may be  
 20 optionally substituted with one or more substituents selected from the group consisting of oxo, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), -S(O)<sub>2</sub>-N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -C(O)-R<sup>2</sup>, -S(O)<sub>n</sub>-R<sup>2</sup>, -OCF<sub>3</sub>, -S(O)<sub>n</sub>-Ar, methylenedioxy, -N(R<sup>2</sup>)-S(O)<sub>2</sub>(R<sup>2</sup>), halo, -CF<sub>3</sub>, -  
 25 NO<sub>2</sub>, Ar, -O-Ar, -C(O)-N(D)(D), -C(O)-N(H)D, and -S(O)<sub>n</sub>-D;

each E is independently selected from the group consisting of Het; O-Het; Het-Het; -O-R<sup>3</sup>; -NR<sup>2</sup>R<sup>3</sup>; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with  
 30 one or more groups selected from the group consisting of R<sup>4</sup> and Het; C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; C<sub>3</sub>-C<sub>6</sub> saturated monocyclic carbocycle, which be optionally benzofused,  
 35 and which may optionally be substituted with one or

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more groups selected from the group consisting of  $R^4$  and Het;  $C_5$ - $C_6$  unsaturated carbocycle, which may optionally be substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_8$ - $C_{10}$  saturated bicyclic carbocycle, which may be optionally substituted with one or more groups selected from the group consisting of  $R^4$  and Het;

each  $R^4$  is independently selected from the group consisting of  $-OR^2$ ,  $-C(O)-NHR^2$ ,  $-S(O)_2-NHR^2$ , halo,  $-NR^2-C(O)-R^2$ ,  $-CN$ ,  $-N(R^2)(R^2)$ ,  $-NO_2$ ,  $-C(O)N(D)(D)$  and  $-C(O)N(H)D$ ;

each  $n$  is independently 1 or 2;

$m$  is an integer selected from 1, 2 and 3;

$p$  is an integer selected from 0 and 1;

$G$  and  $G'$  are independently selected from the group consisting of  $H_2$  and  $O$ ;

each  $X$  and  $X'$  is independently selected from the group consisting of hydrogen;  $-OH$ ;  $-NH_2$ ;  $-SH$ ;  $D$ ; halogen and, if  $X$  and  $X'$  are taken together, oxygen;

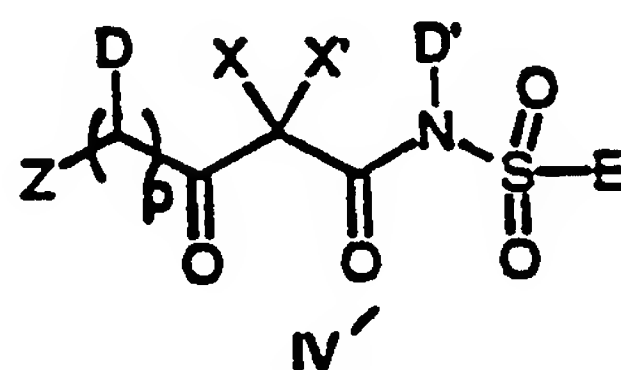
$Z$  is selected from the group consisting of  $-N(D)SO_2E$ ;  $-N(D)SO_2Het$ ;  $-N(H)A$ ;  $-N(D)A$ ;  $-N(H)E$ ;  $-N(H)C(O)N(D)(E)$ ;  $-N(H)-Het$ ;  $-Het$  and  $-N(D)-Het$ ;

each  $A$  is independently selected from the group consisting of  $H$ ; Het;  $-R^1-Het$ ;  $-R^1-C_1-C_6$  alkyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy,  $C_1-C_4$  alkoxy, Het,  $-O-Het$ ,  $-NR^2-CO-N(R^2)(R^2)$  and  $-CO-N(R^2)(R^2)$ ; and  $-R^1-C_2-C_6$  alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of hydroxy,  $C_1-C_4$  alkoxy, Het,  $-O-Het$ ,  $-NR^2-CO-N(R^2)(R^2)$  and  $-CO-N(R^2)(R^2)$ ; and

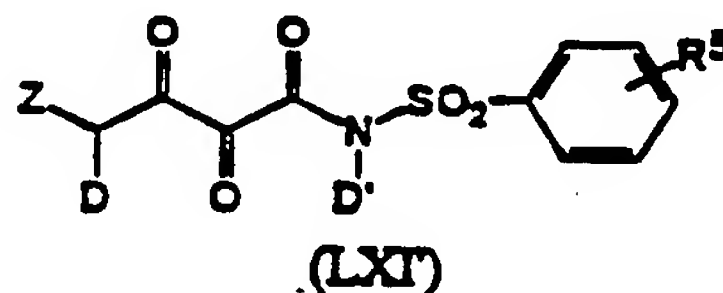
each  $R^1$  is independently selected from the group consisting of  $-C(O)-$ ,  $-S(O)_2-$ ,  $-C(O)-C(O)-$ ,  $-O-C(O)-$ ,  $-O-S(O)_2-$ ,  $-NR^2-S(O)_2-$ ,  $-NR^2-C(O)-$  and  $-NR^2-C(O)-C(O)-$ .

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30. The compound according to claim 29, wherein said compound has the structure of formula IV':



31. The compound according to claim 30, wherein said compound has the structure of formula LXI':

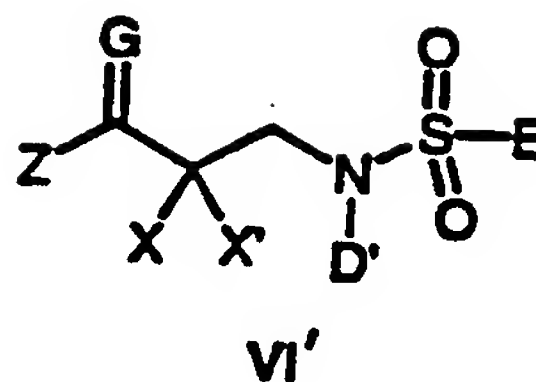


wherein:

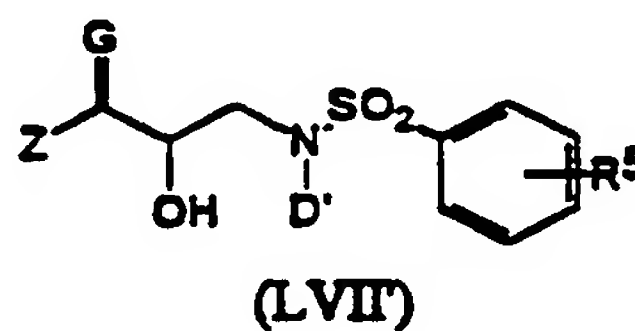
each  $R^5$  is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

32. The compound according to claim 29, wherein said compound has the structure of formula VI':

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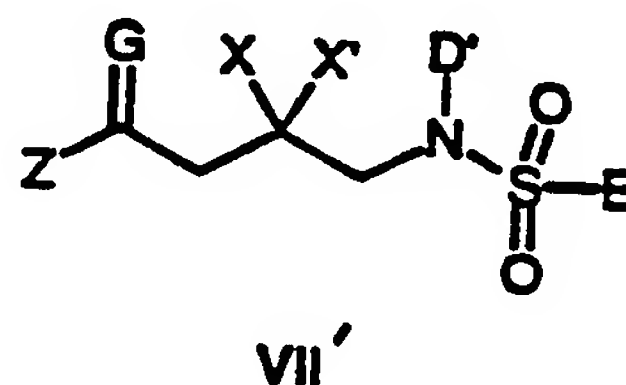
33. The compound according to claim 32, wherein said compound has the structure of formula LVII' :



wherein:

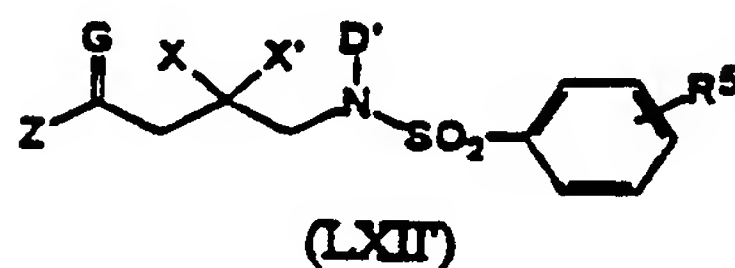
- 5            each R<sup>5</sup> is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

34. The compound according to claim 29, wherein said compound has the structure of formula VII' :



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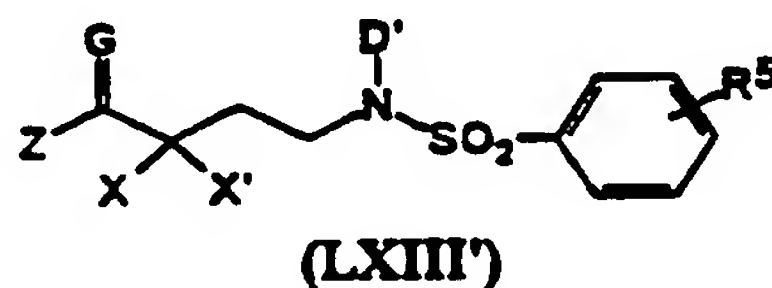
35. The compound according to claim 34, wherein said compound has the structure of formula LXII':



5 wherein:

each  $R^5$  is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

36. The compound according to claim 29 having the  
10 structure of formula LXIII':

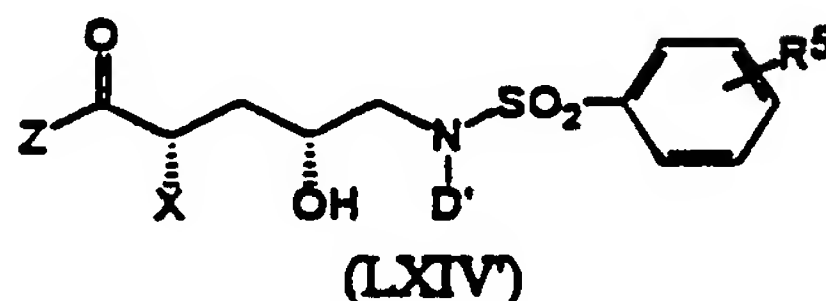


wherein:

each  $R^5$  is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

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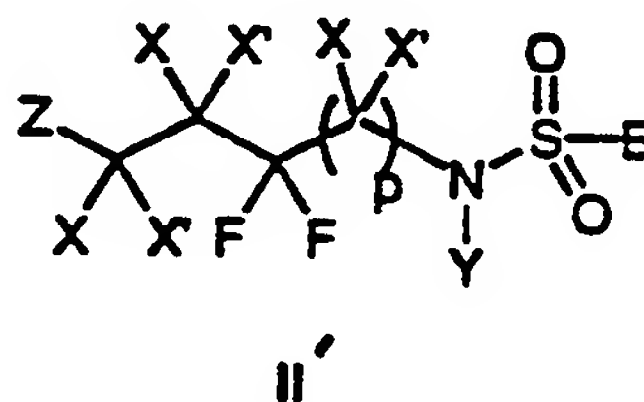
37. The compound according to claim 29 having the structure of formula LXIV' :



wherein:

each  $R^5$  is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

38. A compound of formula II' :



wherein:

each E is independently selected from the group consisting of Het; O-Het; Het-Het; -O-R<sup>3</sup>; -NR<sup>2</sup>R<sup>3</sup>; C<sub>1</sub>-C<sub>6</sub> alkyl, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of R<sup>4</sup> and Het; C<sub>3</sub>-C<sub>6</sub> saturated monocyclic carbocycle, which be optionally benzofused,

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and which may optionally be substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_5$ - $C_6$  unsaturated carbocycle, which may optionally be substituted with one or more groups selected from the group consisting of  $R^4$  and Het;  $C_8$ - $C_{10}$  saturated bicyclic carbocycle, which may be optionally substituted with one or more groups selected from the group consisting of  $R^4$  and Het;

each  $R^4$  is independently selected from the group consisting of  $-OR^2$ ,  $-C(O)-NHR^2$ ,  $-S(O)_2-NHR^2$ , halo,  $-NR^2-C(O)-R^2$ ,  $-CN$ ,  $-C(O)N(D)(D)$  and  $-C(O)N(H)D$ ;

each  $n$  is independently 1 or 2;

$p$  is an integer selected from 0 and 1;

each  $Y$  is independently selected from the group consisting of hydrogen and  $D$ ;

each  $D$  is independently selected from the group consisting of Ar;  $C_1$ - $C_6$  alkyl, which may be optionally substituted with one or more groups selected from the group consisting of  $C_3$ - $C_6$  cycloalkyl,  $-OR^2$ ,  $-R^3$ ,  $-O-Ar$  and Ar;  $C_2$ - $C_4$  alkenyl, which may be optionally substituted with one or more groups selected from the group consisting of  $C_3$ - $C_6$  cycloalkyl,  $-OR^2$ ,  $-R^3$ ,  $-O-Ar$  and Ar;  $C_3$ - $C_6$  cycloalkyl, which may be optionally substituted with or fused with Ar; and  $C_5$ - $C_6$  cycloalkenyl, which may be optionally substituted with or fused with Ar;

each Ar is independently selected from the group consisting of phenyl; 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S,  $S(O)_n$  and  $N(R^2)$ , wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of oxo,  $-OR^2$ ,  $-R^2$ ,  $-N(R^2)(R^2)$ ,

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$-N(R^2)-C(O)-R^2$ ,  $-R^2-OH$ ,  $-CN$ ,  $-CO_2R^2$ ,  $-C(O)-N(R^2)(R^2)$ , halo and  $-CF_3$ ;

each  $R^2$  is independently selected from the group consisting of H and  $C_1-C_4$  alkyl optionally substituted with phenyl, 3-6 membered carbocyclic ring and 5-10 membered heterocyclic ring containing one or more heteroatoms selected from the group consisting of O, N, S and  $S(O)_n$ , wherein said carbocyclic or heterocyclic ring may be saturated or unsaturated and optionally substituted with one or more groups selected from the group consisting of OH,  $NH_2$ , CN,  $C_1-C_4$  alkyl,  $C_1-C_4$  alkoxy, halogen and  $CF_3$ ;

each  $R^3$  is independently selected from the group consisting of H, Het,  $C_1-C_6$  alkyl,  $C_2-C_6$  alkenyl,  $C_3-C_6$  cycloalkyl and  $C_5-C_6$  cycloalkenyl, wherein any member of said  $R^3$ , except H, may be optionally substituted with one or more substituents selected from the group consisting of  $-OR^2$ ,  $-C(O)-NH-R^2$ ,  $-S(O)_n-N(R^2)(R^2)$ , Het,  $-CN$ ,  $-SR^2$ ,  $-CO_2R^2$  and  $NR^2-C(O)-R^2$ ;

each Het is independently selected from the group consisting of  $C_3-C_7$  cycloalkyl;  $C_5-C_7$  cycloalkenyl;  $C_6-C_{10}$  aryl; and 5-10 membered saturated or unsaturated heterocycle, containing one or more heteroatoms selected from the group consisting of N,  $N(R^2)$ , O, S and  $S(O)_n$ , wherein said heterocycle may optionally be benzofused; wherein said heterocycle may be bicyclic or monocyclic; and wherein any member of said Het may be optionally substituted with one or more substituents selected from the group consisting of oxo,  $-OR^2$ ,  $-R^2$ ,  $-N(R^2)(R^2)$ ,  $-R^2-OH$ ,  $-CN$ ,  $-CO_2R^2$ ,  $-C(O)-N(R^2)(R^2)$ ,  $-S(O)_2-N(R^2)(R^2)$ ,  $-N(R^2)-C(O)-R^2$ ,  $-C(O)-R^2$ ,  $-S(O)_n-R^2$ ,  $-OCF_3$ ,  $-S(O)_n-Ar$ , methylenedioxy,  $-N(R^2)-S(O)_2(R^2)$ , halo,  $-CF_3$ ,  $-NO_2$ , Ar,  $-O-Ar$ ,  $-C(O)-N(D)(D)$ ,  $-C(O)N(H)D$ , and  $-S(O)_n-D$ ;

each Z is independently selected from the group consisting of  $-N(D)SO_2E$ ;  $-N(D)SO_2Het$ ;  $-N(H)A$ ;

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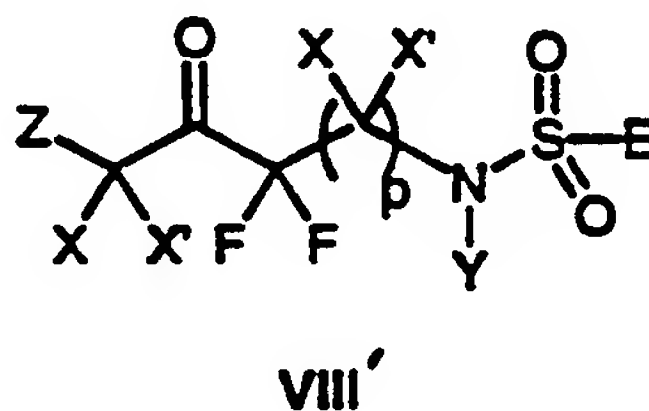
-N(D)A; -N(H)E; -N(H)C(O)N(D)(E); -N(H)-Het; -Het and  
-N(D)-Het;

each A is independently selected from the  
group consisting of H; Het; -R<sup>1</sup>-Het; -R<sup>1</sup>-C<sub>1</sub>-C<sub>6</sub> alkyl,  
5 which may be optionally substituted with one or more  
groups selected from the group consisting of hydroxy,  
C<sub>1</sub>-C<sub>4</sub> alkoxy, Het and -O-Het, -NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>) and -CO-  
N(R<sup>2</sup>)(R<sup>2</sup>); and -R<sup>1</sup>-C<sub>2</sub>-C<sub>6</sub> alkenyl, which may be optionally  
substituted with one or more groups selected from the  
10 group consisting of hydroxy, C<sub>1</sub>-C<sub>4</sub> alkoxy, Het, -O-Het,  
-NR<sup>2</sup>-CO-N(R<sup>2</sup>)(R<sup>2</sup>) and -CO-N(R<sup>2</sup>)(R<sup>2</sup>);

each R<sup>1</sup> is independently selected from the  
group consisting of -C(O)-, -S(O)<sub>2</sub>-, -C(O)-C(O)-, -O-  
C(O)-, -O-S(O)<sub>2</sub>-, -NR<sup>2</sup>-S(O)<sub>2</sub>-, -NR<sup>2</sup>-C(O)- and -NR<sup>2</sup>-C(O)-  
15 C(O)-; and

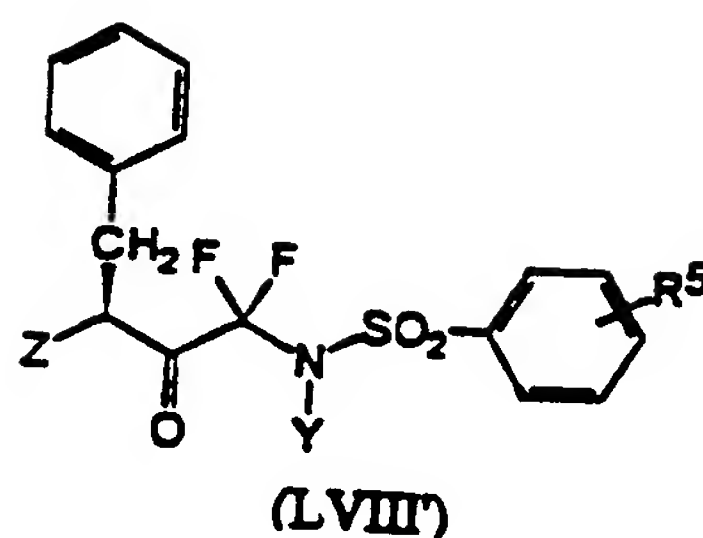
each X and X' is independently selected from  
the group consisting of hydrogen; -OH; -NH<sub>2</sub>; -SH; D and,  
if X and X' are taken together, oxygen.

39. The compound according to claim 38 having the  
20 structure of formula VIII':



40. The compound according to claim 39 having the  
structure of formula LVIII':

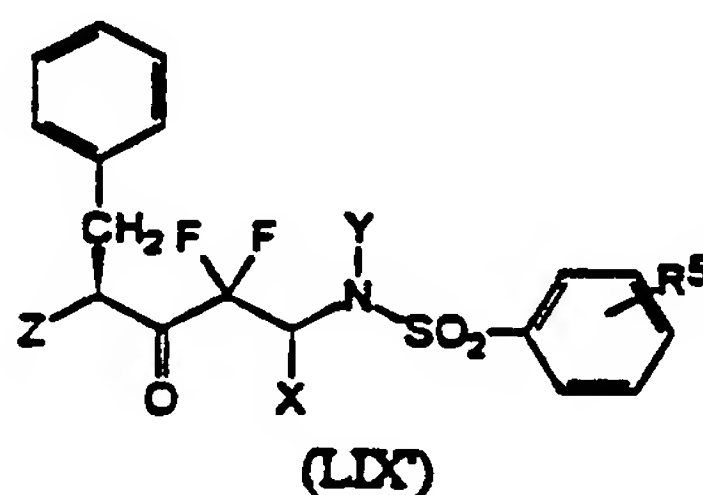
- 200 -



wherein:

each  $R^5$  is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

- 5           41. The compound according to claim 39 having the structure of formula LIX':



wherein:

each  $R^5$  is selected from the group consisting of H, -OH, -OR<sup>2</sup>, -R<sup>2</sup>, -N(R<sup>2</sup>)(R<sup>2</sup>), -N(R<sup>2</sup>)-C(O)-R<sup>2</sup>, -R<sup>2</sup>-OH, -  
 10 CN, -CO<sub>2</sub>R<sup>2</sup>, -C(O)-N(R<sup>2</sup>)(R<sup>2</sup>), halo and -CF<sub>3</sub>.

42. A pharmaceutical composition comprising a pharmaceutically effective amount of a compound according to claim 1, 23, 29 or 38 and a pharmaceutically acceptable carrier, adjuvant or  
 15 vehicle.

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43. The pharmaceutical composition according to claim 42, wherein said pharmaceutical composition is orally administrable.

44. The pharmaceutical composition according to  
5 claim 42, further comprising one or more additional agents selected from the group consisting of other anti-viral agents and immunostimulators.

45. The pharmaceutical composition according to claim 44, wherein said other anti-viral agent or agents  
10 are protease inhibitors or reverse transcriptase inhibitors.

46. The pharmaceutical composition according to claim 45, wherein said protease inhibitor or inhibitors are HIV protease inhibitors.

15 47. The pharmaceutical composition according to claim 46, wherein said HIV protease inhibitor or inhibitors are selected from the group consisting of saquinavir (Ro 31-8959), L-735,524, ABT 538 (A80538), AG 1341, XM 412, XM 450 and BMS 186318.

20 48. The pharmaceutical composition according to claim 45, wherein said reverse transcriptase inhibitor or inhibitors are nucleoside analogs.

49. The pharmaceutical composition according to claim 48, wherein said nucleoside analog or analogs are  
25 selected from the group consisting of zidovudine (AZT), dideoxycytidine (ddC), didanosine (ddI), stavudine (d4T), 3TC, 935U83, 1592U89 and 524W91.

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50. The pharmaceutical composition according to claim 45, wherein said reverse transcriptase inhibitor or inhibitors are non-nucleoside analogs.

51. The pharmaceutical composition according to  
5 claim 50, wherein said non-nucleoside reverse transcriptase inhibitor or inhibitors are delavirdine (U90) or nevirapine.

52. The pharmaceutical composition according to claim 44, wherein said immunostimulator is tuscarasol.

10 53. A method for inhibiting aspartyl protease activity comprising the step of contacting an aspartyl protease with the compound according to claim 1, 23, 29 or 38.

54. A method for reversibly binding an aspartyl  
15 protease comprising the step of contacting the aspartyl protease with the compound according to claim 1, 23, 29 or 38, said compound being covalently bound to a solid matrix.

55. A method for preventing HIV infection in a  
20 mammal comprising the step of administering to said mammal a pharmaceutically effective amount of a pharmaceutical composition according to either claim 42 or 43.

56. A method for preventing HIV infection in a  
25 mammal comprising the step of administering to said mammal a pharmaceutically effective amount of a pharmaceutical composition according to claim 44.

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57. A method for treating HIV infection in a mammal comprising the step of administering to said mammal a pharmaceutically effective amount of a pharmaceutical composition according to either claim 42  
5 or 43.

58. A method for treating HIV infection in a mammal comprising the step of administering to said mammal a pharmaceutically effective amount of a pharmaceutical composition according to claim 44.

10 59. The method according to either claim 55 or 57, further comprising the step of concurrently or sequentially administering to the mammal one or more additional agents selected from the group consisting of other anti-viral agents and immunostimulators.

15 60. The method according to claim 59, wherein said other anti-viral agent or agents are protease inhibitors or reverse transcriptase inhibitors.

61. The method according to claim 60, wherein said protease inhibitor or inhibitors are HIV protease  
20 inhibitors.

62. The method according to claim 61, wherein said HIV protease inhibitor or inhibitors are selected from the group consisting of saquinavir (Ro 31-8959), L-735,524, ABT 538 (A80538), AG 1341, XM 412, XM 450,  
25 and BMS 186318.

63. The method according to claim 60, wherein said reverse transcriptase inhibitor or inhibitors are nucleoside analogs.

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64. The method according to claim 63, wherein  
said nucleoside analog or analogs are selected from the  
group consisting of zidovudine (AZT), dideoxycytidine  
(ddC), didanosine (ddI), stavudine (d4T), 3TC, 935U83,  
5 1592U89 and 524W91.

65. The method according to claim 60, wherein  
said reverse transcriptase inhibitor or inhibitors are  
non-nucleoside analogs.

66. The method according to claim 65, wherein  
10 said non-nucleoside reverse transcriptase inhibitor or  
inhibitors are delavirdine (U90) or nevirapine.

67. The method according to claim 59, wherein  
said immunostimulator is tuscarasol.

68. The use of a compound according to any one of  
15 claims 1-41 for the manufacture of a medicament for  
preventing viral infection in a mammal.

69. The use of a compound according to any one of  
claims 1-41 for the manufacture of a medicament for  
treating viral infection in a mammal.

20 70. The use according to claim 68 or 69 wherein  
said viral infection is HIV infection.

71. A process for producing a compound according  
to claim 1, 23, 29, or 38 comprising the steps of:

1) reacting an amine with either a sulfonylating,  
25 alkylating or acylating agent to give a sulfonamide or  
amide; and

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2) reacting said sulfonamide or amide with an appropriate alkylating, acylating or sulfonylating agent to give an alkyl or acyl sulfonamide.

# INTERNATIONAL SEARCH REPORT

Intern al Application No  
PCT/US 95/02420

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C07C311/29 C07C311/41 C07D307/20 C07D319/06 C07C241/04  
C07D493/04 C07D211/60 C07D317/36 C07D241/04 C07D277/06  
C07D213/81 C07D263/22 C07D217/24

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C07C C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JOURNAL OF ORGANIC CHEMISTRY, vol. 17, no. 1, January 1952 WASHINGTON, DC, US, pages 35-51, B.R. BAKER, ET AL.: 'An antimalarial alkyloid from hydrangea. IV. Functional derivatives of 3-alkyl-4-quinazolones' see compound XII; table III; page 46 ---	1,2,5,7
X	JOURNAL OF THE CHEMICAL SOCIETY, 1949 LETCHWORTH, GB, pages 1378-1380, W.R BOON: 'Respiratory stimulants. Part II. Fully substituted bisureas derived from 2,2'-diaminodiethyl ether and 1,3-diamino-2-alkoxypropanes' see page 1379, paragraph 10 ---	1
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

14 June 1995

Date of mailing of the international search report

22. 06. 95

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+ 31-70) 340-3016

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English, R

# INTERNATIONAL SEARCH REPORT

Intern al Application No  
PCT/US 95/02420

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHEMICAL ABSTRACTS, vol. 66, no. 1, 2 January 1967 Columbus, Ohio, US; abstract no. 2056e, J. DEGUTIS, ET AL.: 'Reactivity of 2-chloroethyl derivatives of aromatic diamines and aminosulphonic acids' page 198; see abstract, compound II & LIETUVOS TSR MODSLU AKAD. DARBAI, SER. B, 1966, (1), 135-147 ---	1,5
X	EP-A-0 022 118 (SANOFI) 7 January 1981 see claim 1 ---	1,2
A	EUROPEAN JOURNAL OF MEDICINAL CHEMISTRY, CHIMICA THERAPEUTICA, vol. 15, no. 6, 1980 PARIS FR, pages 545-550, C. GOLDENBERG, ET AL.: 'Synthèse de dérivés N-amino-3 hydroxy-2 propyl) de N-sulfonylanilines. Étude de leur potentiel antiangineux' see tables V - VII ---	1,2
A	JOURNAL OF MEDICINAL CHEMISTRY, vol. 21, no. 7, July 1978 WASHINGTON, DC, US, pages 673-677, M.G. NAIR, ET AL.: 'Folate analogues altered in the C9-N10 bridge region: N10-tosylisohomofolic acid and N10-tosylisohomoaninopterin' see compounds 9,10 ---	1
A	WO,A,92 17176 (ABBOTT LABORATORIES) 15 October 1992 see page 4 - page 5 -----	1,23,42

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 95/ 02420

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:  
Although claims 53-67 are directed to a method of treatment of the human/  
animal body, the search has been carried out and based on the alleged  
effects of the compound/composition.
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such  
an extent that no meaningful international search can be carried out, specifically:  
  
Claims 1-7, 9-71 have been searched incompletely.  
Claim 8 has not been searched. ./.
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

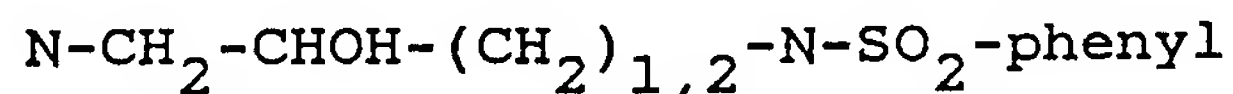
1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all  
searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment  
of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report  
covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is  
restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/

The Markush formulae of Claims 1 and 23 contain almost no fixed structural moiety, namely a sulphonamide group and two carbon atoms (plus a  $\text{CF}_2$  group in the case of claim 23), and the number of values for most of the variables (which often contain cascading meanings) is so large, that the claims encompass an enormous number of compounds. Consequently, a complete search is precluded for practical and economic reasons. The search was based on (but not limited to) the compounds described in the examples, and in particular to compounds containing the partial structure:



Claim 8 contravenes Rule 6.2(a) PCT, which requires that the claims shall not rely on references to the description, and was not included in the search.

The value the variable  $E'$  in Claim 23 is undefined. Presumably, its definition should be as for the variable  $E$  (cf. pages 5-7 of the description).

# INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/US 95/02420

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-22118	07-01-81	FR-A- 2459235	09-01-81
		AT-T- 3638	15-06-83
		JP-A- 56032450	01-04-81
		US-A- 4330542	18-05-82
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WO-A-9217176	15-10-92	US-A- 5151438	29-09-92
		US-A- 5256677	26-10-93
-----			



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>6</sup> : C07C 311/29, 311/41, C07D 307/20, 319/06, C07C 241/04, C07D 493/04, 211/60, 317/36, 241/04, 277/06, 213/81, 263/22, 217/24</p>	<p>A1</p>	<p>(11) International Publication Number: <b>WO 95/24385</b> (43) International Publication Date: 14 September 1995 (14.09.95)</p>
<p>(21) International Application Number: PCT/US95/02420 (22) International Filing Date: 24 February 1995 (24.02.95) (30) Priority Data: 08/207,580 7 March 1994 (07.03.94) US (60) Parent Application or Grant (63) Related by Continuation US 08/207,580 (CIP) Filed on 7 March 1994 (07.03.94) (71) Applicant (for all designated States except US): VERTEX PHARMACEUTICALS INCORPORATED [US/US]; 40 Allston Street, Cambridge, MA 02139-4211 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): TUNG, Roger, Dennis [US/US]; 54 Richfield Road, Arlington, MA 02174 (US). SALITURO, Francesco, Gerald [US/US]; 25 Baker Drive, Marlborough, MA 01752 (US). DEININGER, David, D. [US/US]; 4 Frazer Road, Arlington, MA 02174 (US). MUR- CKO, Mark, Andrew [US/US]; 520 Marshall Street, Hollis-</p>		<p>ton, MA 01746 (US). NOVAK, Perry, Michael [US/US]; 35 Debbie Lane, Milford, MA 01757 (US). BHISETTI, Govinda, Rao [IN/US]; 70 Grassland Street, Lexington, MA 02173 (US). (74) Agents: HALEY, James, F., Jr. et al.; Fish &amp; Neave, 1251 Avenue of the Americas, New York, NY 10020-1104 (US). (81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TT, UA, UG, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).  <b>Published</b> <i>With international search report.</i></p>
<p>(54) Title: SULPHONAMIDE DERIVATIVES AS ASPARTYL PROTEASE INHIBITORS (57) Abstract  This invention relates to a novel class of sulfonamides that are aspartyl protease inhibitors. In one embodiment, this invention relates to a novel class of aspartyl protease inhibitors characterized by specific structural and physicochemical features. This invention also relates to pharmaceutical compositions comprising these compounds. The compounds and pharmaceutical compositions of this invention are particularly well suited for inhibiting HIV-1 and HIV-2 protease activity and consequently, may be advantageously used as anti-viral agents against the HIV-1 and HIV-2 viruses. This invention also relates to methods for inhibiting aspartyl protease activity and methods for treating viral infections using the compounds and compositions of this invention.</p>		

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<b>BB</b>	Barbados	<b>GN</b>	Guinea	<b>NE</b>	Niger
<b>BE</b>	Belgium	<b>GR</b>	Greece	<b>NL</b>	Netherlands
<b>BF</b>	Burkina Faso	<b>HU</b>	Hungary	<b>NO</b>	Norway
<b>BG</b>	Bulgaria	<b>IE</b>	Ireland	<b>NZ</b>	New Zealand
<b>BJ</b>	Benin	<b>IT</b>	Italy	<b>PL</b>	Poland
<b>BR</b>	Brazil	<b>JP</b>	Japan	<b>PT</b>	Portugal
<b>BY</b>	Belarus	<b>KE</b>	Kenya	<b>RO</b>	Romania
<b>CA</b>	Canada	<b>KG</b>	Kyrgystan	<b>RU</b>	Russian Federation
<b>CF</b>	Central African Republic	<b>KP</b>	Democratic People's Republic of Korea	<b>SD</b>	Sudan
<b>CG</b>	Congo	<b>KR</b>	Republic of Korea	<b>SE</b>	Sweden
<b>CH</b>	Switzerland	<b>KZ</b>	Kazakhstan	<b>SI</b>	Slovenia
<b>CI</b>	Côte d'Ivoire	<b>LI</b>	Liechtenstein	<b>SK</b>	Slovakia
<b>CM</b>	Cameroon	<b>LK</b>	Sri Lanka	<b>SN</b>	Senegal
<b>CN</b>	China	<b>LU</b>	Luxembourg	<b>TD</b>	Chad
<b>CS</b>	Czechoslovakia	<b>LV</b>	Latvia	<b>TG</b>	Togo
<b>CZ</b>	Czech Republic	<b>MC</b>	Monaco	<b>TJ</b>	Tajikistan
<b>DE</b>	Germany	<b>MD</b>	Republic of Moldova	<b>TT</b>	Trinidad and Tobago
<b>DK</b>	Denmark	<b>MG</b>	Madagascar	<b>UA</b>	Ukraine
<b>ES</b>	Spain	<b>ML</b>	Mali	<b>US</b>	United States of America
<b>FI</b>	Finland	<b>MN</b>	Mongolia	<b>UZ</b>	Uzbekistan
<b>FR</b>	France			<b>VN</b>	Viet Nam
<b>GA</b>	Gabon				